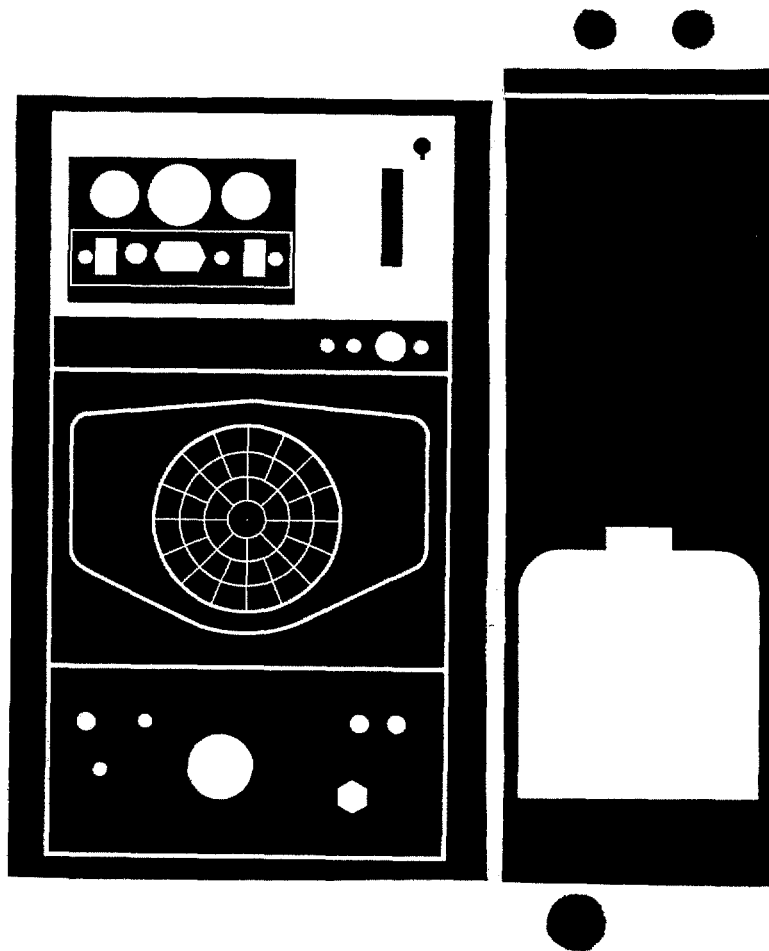


HYDRA-CAT/M



HYDRAMASTER[®]
Corporation

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Warranty

Warranty Information	Inside back cover
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GENERAL INFORMATION

This manual contains installation and operation instructions as well as information required for proper maintenance, adjustment and repair of this unit. Since the first and most important part of repair work is the correct diagnosis of the trouble, a general troubleshooting section and component manual troubleshooting charts have been included for your convenience.

Unlike the garden tractor, lawnmower and cement mixer, all having one or two functions to perform, the truck-mounted carpet cleaning plant has many functions to perform simultaneously.

- Engine has to run consistent RPM.
- Vacuum has to pull air and dirty water back from cleaning site.
- Water pump provides stable pressure at proper water flow for cleaning.
- Chemical has to be injected into the water stream at the right consistency.
- Heater must maintain proper heat.
- Vacuum tank must store dirty water until drained.

As you can see, it is not just a turn key operation with only one thing to worry about, **Does it start?!**

HOW THE SYSTEM WORKS

The water system takes incoming water at tap (low) pressure, combines it with chemical from the chemical system automatically, pumps it under high pressure through the heating system and out to the cleaning tool. After being sprayed into the carpet being cleaned, the water/chemical/soil solution is extracted by the vacuum system and returned to the waste recovery tank.

As there is no guess work in the manufacture of these highly advanced cleaning plants, there must be none in preparing it to get the job done in the field. It is the purpose of this manual to help you properly understand, maintain and service your cleaning plant. Follow the directions carefully and you will be rewarded with years of profitable trouble-free operation.

It is imperative that **no section** be overlooked when preparing for operation of this equipment.

WARNING

The manufacturer uses this symbol throughout the manual to warn of possible injury or death.

CAUTION

This symbol is used to warn of possible equipment damage.

MACHINE SPECIFICATIONS

FRAME: 21"W, 56"L, 34"H. Steel with Baked-on Epoxy Finish.

WEIGHT: 800 pounds.

COWLING: Steel with Baked-on Epoxy Finish.

ENGINE: M/Series 20 BHP Kohler M20 Electronic Ignition.

S/Series CCKB 20BHP Onan Opposed, Two Cylinder, Four Cycle.

IGNITION: Standard Points (Kohler-Electronic), Keystart.

HI-PRESSURE PUMP: Tri-Plex Piston - Cat 290 - 3.5GPM - 1200 PSI - @ 1200 RPM.

VACUUM BLOWER: 4MF Sutorbuilt W/14 Hg Safety Relief.

CHEM. SYSTEM: Auto Proportioning Flow Meter Controlled.

HEATER: Propane Fired, Thermostatically Controlled. (180,000 BTU).

INSTRUMENTS: 1-1000 High Pressure Gauge, Temp. Gauge, Vacuum Gauge, Hour Meter, Chemical Flow Meter, Ignition Key Start and on Ind. Lights.

RECOVERY TANK: 65 Gallon Aluminum Epoxy Finish.

CLEANING WAND: Stainless Steel w/Heat Shield Grip and Replaceable Vacuum Lips.

HI-PRESSURE HOSE: 1/4" High Temp Lined/Vinyl Covered, Hose rated to 2750 PSI, Q.C. rated to 800 PSI

VACUUM HOSE: 2" Reinforced, 1 1/2" Reinforced.

STANDARD FEATURES: Basic Console, 65 Gallon Vacuum Tank; 11" S/S Cleaning Wand; 100' 2" Vacuum Hose; 50' 1 1/2" Vacuum Hose; 150' H.P. 1/4" Solution Hose; Battery Box; Through Floor Connections for Gasoline and Propane Hook-up; Tie Down Cleats; Vacuum Hose Connections; Operation Manual; Steel Legs with Casters; Clutch; Freeze Guard.

OPTIONAL FEATURES: Stair Tool, Additional 2" Vacuum Hose in 50' Lengths; additional 1/4" Pressure Hose in 50' Lengths; Rotary Jet Extractor.

SPARE PARTS RECOMMENDATION

Because your truck-mounted unit is capable of generating several hundred dollars per day, down-time on the unit can be very expensive.

In order to minimize such down-time, it is strongly recommended by the manufacturer that you purchase and keep in you truck the following spare parts:

PART NO.	DESCRIPTION	QTY.
000-078-015	Flow Meter Kit	1
000-078-019	Wand Valve Plunger Kit	1
000-078-034	Pressure Bypass Valve Kit	1
000-076-007	Spray Jet 8008E	1
000-049-029	Recovery Tank Filter Bag	2
000-078-001	Cat 290 Short Cup Kit Standard	1
000-078-004	Cat 290 Hot Cup Kit (Optional)	1
000-049-023	Screen Garden Hose	6
000-052-050	440 Male Quick Connect	1
000-052-051	440 Female Quick Connect	1
000-052-052	660 Male Quick Connect	1
000-052-053	660 Female Quick Connect	1
000-106-013	Engine Spark Plug	2
010-022	Pump Drive Belt, m-Belt	1
010-017	S Cat Belt	1

HOW TO ORDER

To obtain a proper diagnosis of your malfunction, and to order warranty replacement parts, it is important that you proceed in the following manner:

1. Call HydraMaster Warranty/Service Dept. at (206) 775-7275.
2. Give the Warranty/Service Representative the following information:
 - A. Name of your company and your address.
 - B. Equipment Model (i.e. Hydra-Cat, Bobcat 2, etc.).
 - C. Date of purchase.
 - D. Hours on the unit.
 - E. Serial number of unit.
 - F. Name of person authorized to order parts.
 - G. Salesman unit purchased from.
 - H. Description of malfunction.
 - I. Pressure readings on high pressure gauge with wand turned on and off.
3. If warranty replacement parts are needed, please specify method of shipment desired. **NOTE:** All replacement parts are sent freight collect, via:
 - A. U.P.S.
 - B. Air Freight
 - C. Air Mail
 - D. Air Express
 - E. Auto Freight
4. Do not give malfunctioning parts to a HydraMaster Sales or Service Representative. **All parts must be returned directly to HydraMaster, freight prepaid.**

PARTS ORDERS

To expedite your parts needs, please call your sales representative. In most instances, he either stocks or has access to parts through a regional service center.

In the event parts are unavailable locally, contact the factory and coordinate your needs. If this becomes necessary, always indicate the method of shipment you desire, i.e. U.P.S. Blue Label, Air Freight, Air Express, etc.

HydraMaster Parts Dept. phone (206) 775-7276.

ONE FINAL NOTE

Any questions you have regarding the warranty program should be directed to the Warranty/Service Dept. Personnel at HydraMaster Corporation.

We shall always endeavor to be fair in our evaluation of your warranty claim, and shall provide you with a complete analysis of our findings.

HydraMaster Warranty Policy (Inside back cover)

Effective May 1, 1988

HydraMaster warranty covers only defective materials and/or workmanship for the periods listed. Labor, and/or diagnostic reimbursement is specifically excluded.

PURCHASER'S RESPONSIBILITY

PRIOR TO ARRIVAL OF UNIT:

- Install 5/8" exterior plywood flooring in vehicle and cover with artificial turf.
- Have belly mounted propane tank installed on vehicle. Tank must be propane vapor type.
- **Caution** Purchase heavy duty 42-60 amp hour battery and have battery 'slow' charged if new. If battery is not fully charged damage can occur to the engine charging regulator.

READING OF OWNERS MANUAL:

- It is the purchaser's responsibility to read the unit operation manual and to familiarize himself with the information contained therein.

SALES REPRESENTATIVE'S RESPONSIBILITY

ACCEPTANCE OF SHIPMENT:

- If unit shows any outward signs of damage, do not sign the delivery receipt until you have closely inspected the unit and noted any damage on the delivery receipt. Have the freight company representative acknowledge the damage by signing the notation of damage on the delivery receipt.
- The salesman from whom you purchased your unit is responsible for supervising the correct installation of the unit in your vehicle and thoroughly training you in its operation and maintenance.

CORRECT INSTALLATION INCLUDES:

Supervising the purchaser in the following:

- Installation of through-floor fittings for propane and gasoline fuel lines; installing propane regulator included with unit, **outside** vehicle; placing unit and recovery tank in vehicle and securing them with bolts or tie down cleats; connecting all propane and gasoline lines; connecting battery; checking pump, vacuum blower and engine oil levels, prior to starting unit; starting unit to check engine to see that all systems function normally; also checking all hoses, wands, etc., for correct operation.

TRAINING SHALL INCLUDE:

- Thorough review of the operation manual with purchaser; instruction and familiarization in: how to correctly start up and shut down unit; how to correctly clean with the unit; how, where and how often to check and change component oil levels; how the unit's systems work; how to troubleshoot the unit; how to do basic repairs; safety precautions and their importance; freezing damage and how to avoid it and a thorough review of the unit warranty and warranty procedures.

HOURS:

MONDAY THROUGH FRIDAY

8:00 am TO 6:00 pm
PACIFIC STANDARD TIME



PST



ROCK MT.



CENTRAL



EASTERN

TELEPHONE NUMBERS

GENERAL OFFICES:	(206) 775-7272
PARTS DEPT:	(206) 775-7276
SERVICE/WARRANTY:	(206) 775-7275
NEW EQUIPMENT SALES AND MARKETING:	1-800-426-1301
FAX	(206) 771-7156

TRUCK PREPARATION

Manufacturer recommends the installation of plywood flooring covered with poly propylene backed astroturf (do not use rubber-backed) in the vehicle prior to installation of machine. This provides a metal to cushion mounting rather than metal to metal, provides insulation and makes an attractive van interior. Astroturf should be color keyed to van interior.

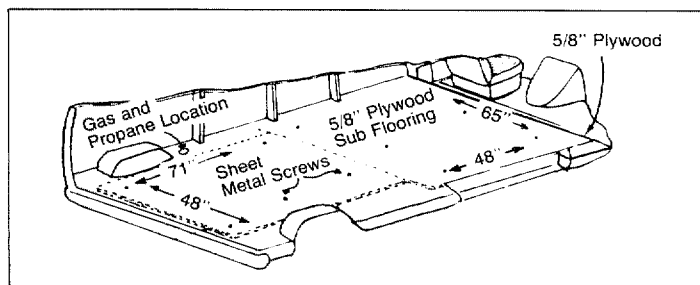
Materials Needed:

1. 2 sheets 4x8x5/8" exterior plywood
2. 6'x12' piece of commercial astroturf
3. 16-1 1/2" sheet metal screws
4. 1 quart marine adhesive (optional)
5. 1 staple hammer w/1/2" staples

(See illustration for correct placement of plywood flooring)

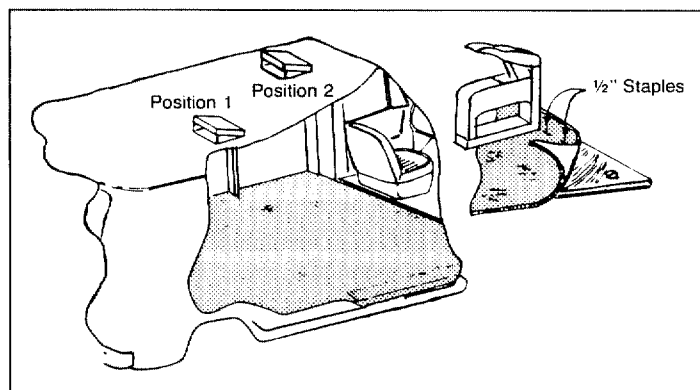
TRUCK PREPARATION ILLUSTRATION

FIRST, cover the truck bed with 5/8" plywood using metal screws to secure it as shown.



SECOND, select the appropriate color astroturf to match your van and cover the plywood and staple in place. A standard van requires a piece 6 feet by 12 feet.

THIRD, for added ventilation, an aluminum roof vent should be added over the location selected for mounting the machine. This will allow hot air from the heater to escape.



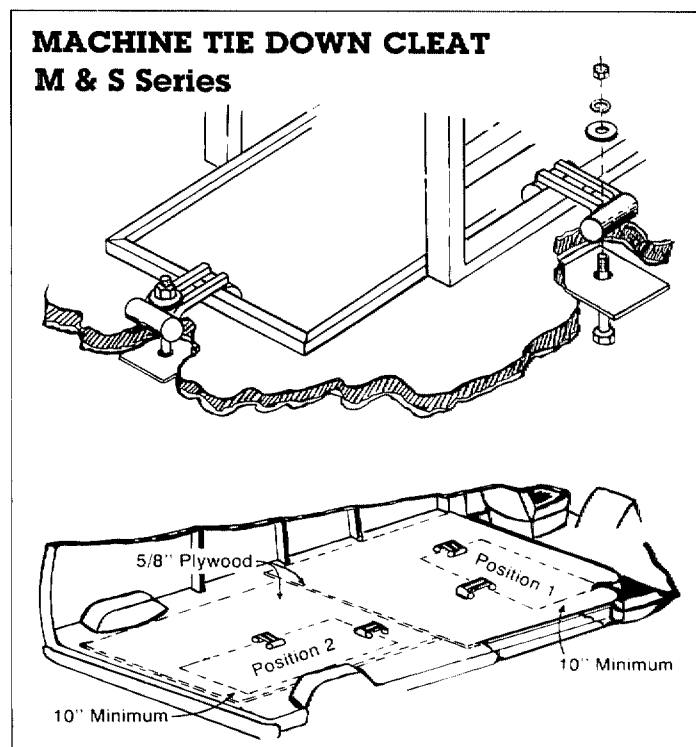
PLACEMENT OF UNIT IN VEHICLE

There are two recommended unit placements:

- A. SIDE DOOR:** Most installations are side door. This provides rear access for accessories and hoses as well as unobstructed access to component/working side of machine, thus making it a bit easier to perform maintenance and/or repair without removing unit from the truck.
- B. REAR DOOR:** Although this location partly limits working access, it does direct the noise away from the cleaning site. Some cleaners in the colder areas prefer this location because it puts the weight mass over the rear wheels for better traction in ice and snow. Rear mounting requires the unit to be slid to the right side as far as possible. This not only provides adequate working space on the component side of the unit but also makes better weight distribution inside the van (engine and component weight line up over drive shaft). Also, it is physically easier to load unit into rear door due to height of van bed.

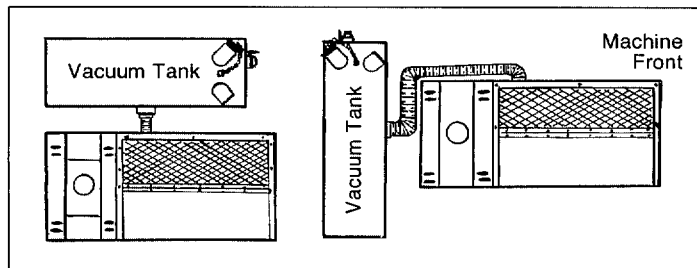
WARNING: Ensure that machine is well secured to the floor of van with hardware supplied. Sudden or crash stop will cause machine to rocket forward, all 750 lbs. worth! Protect yourself and the machine: **SECURE IT!**

MACHINE TIE DOWN CLEAT M & S Series



MACHINE INSTALLATION

There are two ways of positioning the machine in the truck as shown. There are also two locations for the vacuum recovery tank to be positioned. First, the standard way with the tank directly alongside the machine. Second, with the tank across the back of the machine as shown below; this location is most space efficient.



Whichever way you select, make sure the tank and machine are secured to the floor of the van to insure driver safety.

It is important that the machine be placed as close to the door as possible so that outside air can be pulled into the engine for proper cooling.

WARNING: It is recommended by the manufacturer that the exhaust from the front of the machine be vented down under the truck to prevent carbon monoxide from entering the job site. Always park the truck so the exhaust is blowing away from the job site.

The manufacturer also recommends that installation of aluminum vents in the truck roof to allow heat from the heater to escape.

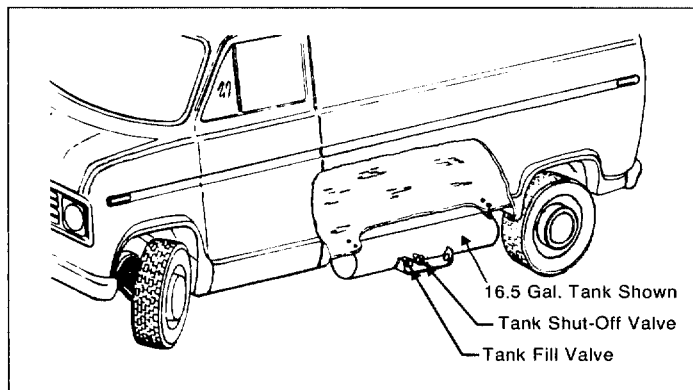
WARNING: Never operate this machine with a portable propane tank or a portable gas can inside the truck. The heater is an open flame type and could cause a fire or explosion.

Mount a fire extinguisher just inside the rear or side door for emergencies.

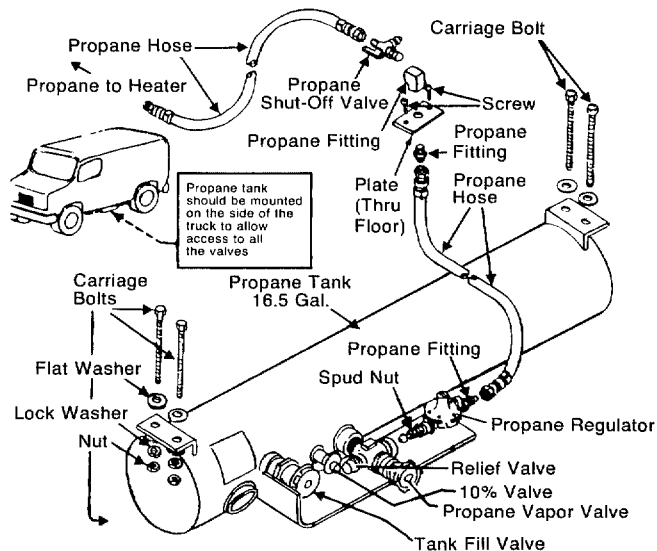
PROPANE TANK LOCATION

Either the 10 gallon or 16.5 gallon propane tank will fit this location. Have your local propane dealer install the tank you select and purchase. The machine will come with the proper propane regulator. (Tank must have vapor outlet.)

WARNING: Do not use a portable propane tank inside the truck or van. Besides being dangerous it is unlawful in most states.



PROPANE TANK PLUMBING

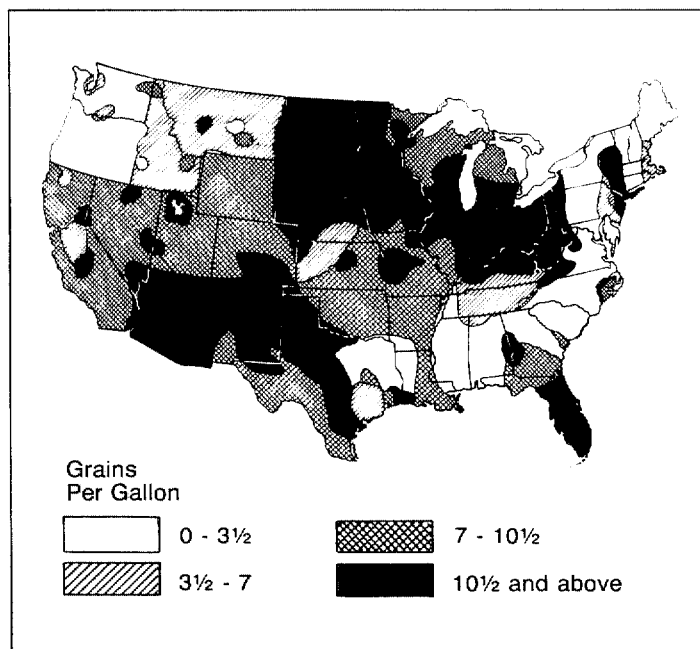


HARD WATER AREA MAP

The quality of water varies greatly throughout the United States and influences the reliability and efficiency of equipment in direct proportion to its level of hardness. The map below defines areas which compromise fluid related components such as hoses, fittings, heaters, pumps, valves and water cooled engines.

Cleaning efficiency and equipment life is increased, chemical use decreased and the appearance of cleaned carpets enhanced when water softeners are incorporated in hard water areas. Manufacturer strongly urges the use of water softener units in areas exceeding $3\frac{1}{2}$ grains per gallon. Using the legend as a reference, determine the quality of water in your area and take action immediately should it be necessary.

(For installation diagram see machine installation section)



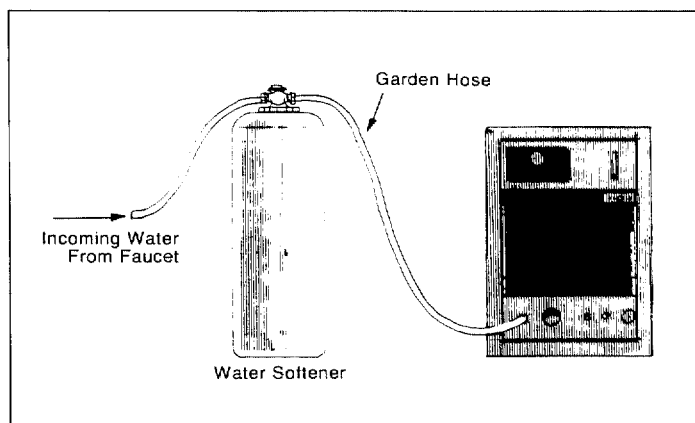
WATER SOFTENER

Many areas of the country have an excess of minerals in the water which results in what is commonly called "hard water". These minerals tend to adhere to the insides of heater coils and other parts of the machines causing damage and a loss of cleaning effectiveness.

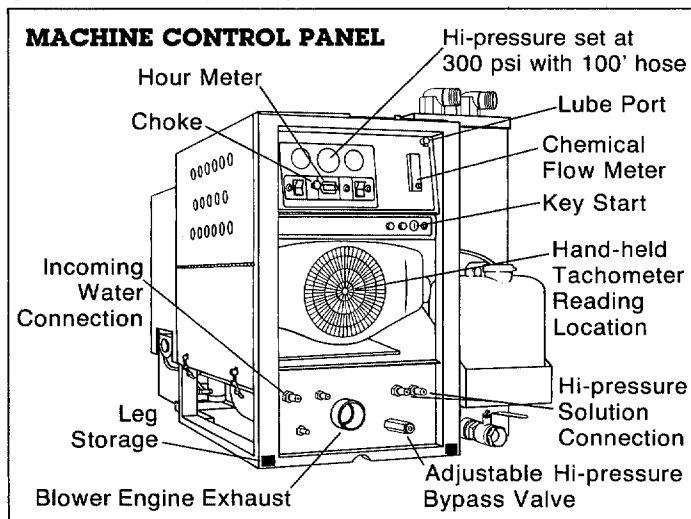
Reports from several of our machine users commending the results of the use of water softeners in conjunction with their machines prompts us to recommend the procedure to everyone in a "hard water" area.

The relatively low cost of a water softener service is more than made up for in the increased life of machine parts and continued cleaning efficiency. The water softener will also increase the effectiveness of the cleaning chemical being used, therefore, less chemical will be needed.

Contact a water softener distributor in your area for information on the rental of a simple water treatment unit to carry in your truck. Be sure to change the water softener in accordance with the capability of the softener. Example: If the softener will treat 900 gallons of water and the machines uses an average of 30 gallons per hour of use, and an average of 5 hours a day, would be 150 gallons a day. 5 days would equal 750 gallons of water, therefore, the softener would be changed every 6 working days for maximum softening.



OPERATING INSTRUCTIONS



START UP

1. Perform daily/periodic maintenance as specified by the owner's manual.
2. Connect all required hoses.
3. Connect cleaning tool to length of hose required to perform cleaning.
4. **Caution:** Mix tank must be full prior to ignition.
5. Start engine (choke as required). Engine is at operating speed (recommended - 2600 RPM). Allow warm-up period of 2-5 minutes.
6. Spray wand to void all air from system. As the mix tank is in a fill cycle, the chemical flow meter may be adjusted to your desired setting. NOTE: Recommended carpet cleaning pressure is 250-300 PSI.
7. Once all air is voided from system, heater may be ignited. NOTE: If not familiar with operation of this heater, refer to heater section of the manual.
 - A. Open propane valve on the tank.
 - B. Ignite pilot on the heater.
 - C. To ignite burner, turn dial to on position.NOTE: If you suspect that the unit has been frozen - DO NOT light the heater. Thaw the heater and check for leaks.
8. Turn on burner, adjust dial to normal or slightly below for 200° F.
9. Commence cleaning operation. NOTE: Chemical flow meter set at 5 GPM is a 1 to 30 mix ratio and 10 GPH is 1 to 15 ratio. When flow meter is set at 10 GPH, you will be using what most chemical manufacturers recommend at 5 GPH.

SHUT DOWN

1. Turn heater to off position. Spray wand for a least 3 minutes to allow the heater coils to cool.
2. Close valve on propane tank.
3. Remove vacuum hose.
4. Flush clear water through chemical system for 10 seconds. (Vinegar should be rinsed through system weekly.) Turn off chemical flow meter.
5. Turn on cleaning tool to flush chemical from unit hoses and cleaning tool.

NOTE: If freeze guard is necessary, perform steps 1 & 2 of freeze guard procedure at this time.
6. At this time, the blower should be lubricated with LPS 1 or WD 40.
7. Shut engine down.
8. Drain vacuum tank. Vacuum filter should be cleaned prior to mobilization of van.

NOTE: If freeze guard is necessary, perform steps 3-7 of freeze guard procedure at this time.

OPERATION PRECAUTIONS

MACHINE ADJUSTMENTS:

Although this unit has been factory adjusted, it may require additional adjustments to achieve optimum performance; i.e. altitude may require carb adjustment and ambient temperatures may require heat control adjustment. When required, consult an authorized representative.

ENGINE COOLING:

CAUTION: Units employing air cooled engines must not be incapacitated within a van with doors and windows closed. Excessive temperatures within the engine will result in premature engine failure and a compromise of applicable warranty.

LEVEL OPERATION:

CAUTION: During operation, van or trailer must be parked on level ground not to exceed + or -10°. Failure to insure proper leveling may prevent proper internal lubrication of engine, vacuum and/or high pressure components.

FREEZE PROTECTION:

CAUTION: Mother nature gives little warning as to her cold spells. Therefore, protecting this equipment from freezing will save costly down-time. Placing an electric heater in the truck or parking the truck indoors, will help to insure against freezing.

LIGHTING HEATER:

WARNING: Never put your face down close to the opening of the heater when lighting.

STRONG PROPANE ODOR:

WARNING: Never light the heater if you smell a strong odor of propane around the heater.

FREEZE PROTECTION

Any freezing of this machine is not covered by warranty and during the colder months of operation, careful protection should be of utmost concern.

THE FOLLOWING PRECAUTIONS ARE RECOMMENDED:

1. Run machine before leaving for the first job to insure nothing has frozen the night before, including hoses and wand.
2. Insulate the garden hose from the cold ground by running it through an extra 1 1/2 inch vacuum hose.
3. Leave truck doors closed until time cleaning begins, then open slightly.
4. On extremely cold days propane does not vaporize as quickly, therefore, venting the warm exhaust over to blow on the propane tank will stabilize the propane flow. (This is necessary if you notice a drop in heat or a low burning flame in the heater.)
5. In colder climates, insulating the truck walls and floor boards will help protect the unit.
6. Don't procrastinate during the cleaning operation or the hot water solution line will also freeze on the ground. The solution line should be insulated in extremely cold climates.
7. Whenever possible, the truck and machine should be stored in a heated garage at night or over the weekend. If not possible, place a 1500 watt electric heater inside the truck, aimed directly at the machine. Never use a propane heater - it causes excessive moisture on the truck ceiling and the possibility of it going out is higher. If the machine and truck are left outside with a heater, you should first drain all possible water from the machine cleaning tools and hoses. (They freeze also.)

TO DRAIN THE MACHINE, FOLLOW THESE STEPS:

- A. Before shutting off the machine, remove the chemical line from the chemical jug and place in a mixture of 50/50 anti-freeze and water. With the cleaning tool on, allow mixture to fill chemical system back to the chemical mix tank.
- B. Loosen the petcock valve on your bypass drain hose and allow the water to drain thoroughly from the mix tank.
- C. To remove the water from the heater and pump use the freeze guard which is a small air compressor. Using the correct connectors, first blow air into the high pressure solution male quick connect. This will force the water through the heater back through the pump and into the chemical mix tank to be drained out through the petcock valve to the ground. By loosening the bypass knob, the air will be allowed to flow more freely through the system. Next, blow the air into the incoming water quick connect and force that water into the chemical mix tank to be drained out.
- D. Remember to close the drain valve prior to next operation of your unit.

BE SURE IT'S PROTECTED!

Freezing will cause GRIEF, MONEY and DOWN-TIME. Don't mess with Mother Nature!

CLEANING AND CHEMICAL PRECAUTIONS

Your mobile carpet cleaning plant has been engineered using the latest and most sophisticated technology available, to produce the finest carpet cleaning results possible. Despite this however, it remains only a tool of the carpet cleaning trade, and it can produce only as good a job as the person operating it.

There are no short cuts to good carpet cleaning, it requires time, cleaning knowledge and the use of good chemicals.

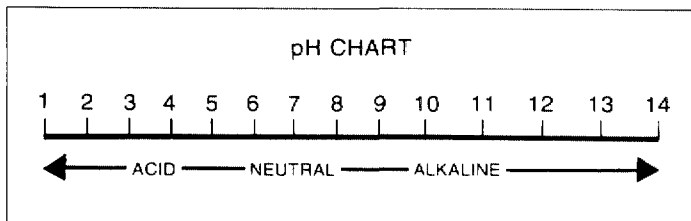
Manufacturer recommends the use of spotting agents, and traffic lane cleaners prior to the actual cleaning of carpeting, as required.

CAUTION: When cleaning cut-pile acrylic plush carpets, using high heat setting may result in fiber damage on this type of carpet.

The use of some chemicals through your mobile carpet cleaning plant can seriously damage the internal plumbing, high pressure pump and heater. (Chemical such as concentrated acids and some paint oil and grease removers w/high concentration of solvents.)

Manufacturer recommends only the use of chemicals containing rust and corrosion inhibitors and water softening agents to prevent chemical build-up.

NOTE: At no time should a chemical solution with a PH of less than 7 or higher than 10 be used in the unit.



CLEANING STROKE PROCEDURE/OVER-WETTING

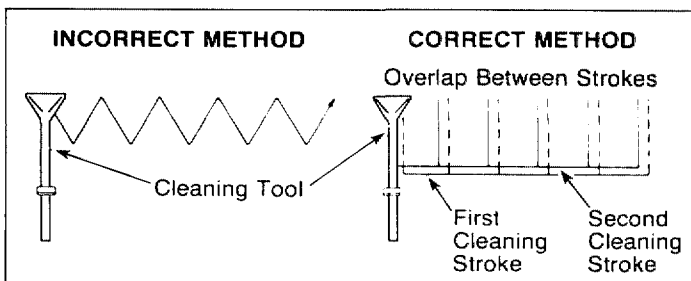
Purpose:

To eliminate excess moisture remaining in the carpet fiber and the sawtooth appearance which results from diagonal movement of the cleaning tool on all types of carpet.

Procedure:

Always move the cleaning tool in smooth forward and backward strokes. Apply **slight** pressure to the forward stroke while the solution is injected into the carpet. When extracting (drying), apply firm pressure on the forward stroke to ensure a positive "lock" for the vacuum and minimize the "hopping" effect resulting on unsmooth carpet. During the forward and reverse strokes, movement to the right or left should only be accomplished at the extreme rear of the stroke. Overlapping is also important to ensure even application of solution to prevent saturation when cleaning wand is stopped twice at the same point at the rear of the cleaning stroke.

Failure to adopt this procedure can result in increased chance of "clean streaks", fiber shrinkage, brown out, and longer drying periods.



Over-Wetting

Over-wetting is annoying to all concerned and sometimes leaves a bad impression of the cleaning process used.

These are several areas that will cause over-wetting:

1. Too few vacuum strokes or improper saw tooth vacuum strokes as shown above.
2. Obstructed, kinked or cut hoses.
3. Vacuum tank drain valve left partially open.
4. Clogged vacuum blower filter or vacuum tank lid not sealing properly.
5. Cleaning a heavily foam-saturated carpet without defoamer. (We recommend crystal type.)

WATER AND CHEMICAL FLOW OPERATION

This system has been designed to be the most simple and trouble-free ever.

The incoming water flows directly to the mix tank. Water will now flow through a proportioning valve which will simultaneously mix the chemical to achieve your desired solution. The mix tank is equipped with 2 different float valves, one of which responds to the water level of the tank and will maintain the proper volume of solution to be reserved for the cat pump. The secondary float valve is a safety valve that is designed to protect your system from sudden or unexpected loss of water supply. If, for example, the water source at the house was turned off, the water level of the mix tank would drop, activating the secondary valve which automatically kills the engine.

UNIT WITH CLUTCH: If mix tank water level drops, clutch will disengage.

In conjunction with the incoming flow, the chemical ratio may be obtained by an adjustment of the chemical flow meter during the fill cycle of the mix tank. The chemical will flow from the chemical jug to the chemical flow meter, then to the proportioner where it is distributed into the mix tank at your desired proportion. This line should be flushed with vinegar weekly to prevent abnormal chemical build-up. This may be done by removing the clear plastic hose from the chemical jug and inserting it into a one quart container of vinegar. This should be done with the chemical flow meter setting on 10 GPH with heater "off". Simply spray the wand for the duration of the vinegar in the one quart container, then repeat the process with one quart of clear water to void all lines of vinegar.

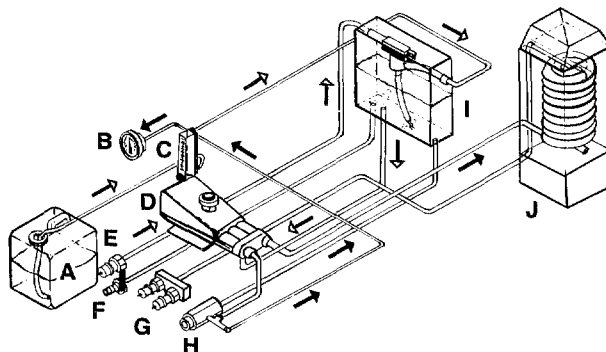
NOTE: With this unique chemical system, your chemical flow is proportioned to the filling cycles of the mix tank, not the direct spraying of the wand. Therefore, it is possible that as your wand is spraying, you may have no chemical flow. Also, the converse is true in that you may not be spraying your wand but, if the mix tank is in a filling cycle your chemical flow meter may read your desired flow.

This chemical system will mix a 1 to 30 ratio when flow meter is set at 5 GPH. Most chemical suppliers will recommend a 1 to 15 ratio therefore you can either set the flow meter at 10 GPH, giving you a 1 to 15 ratio of chemical to cleaning water, or double the recommended strength of chemical in the 5 gallon jug and set the flow meter at 5 GPH, thereby attaining a 1 to 15 ratio. (It is recommended that you set the flow meter at 10 GPH for overall best results.)

The water will now be siphoned from the bottom of the mix tank to the Cat Pump. If the wand is not spraying, the water will bypass from the bottom of the brass pressure relief valve to the mix tank.

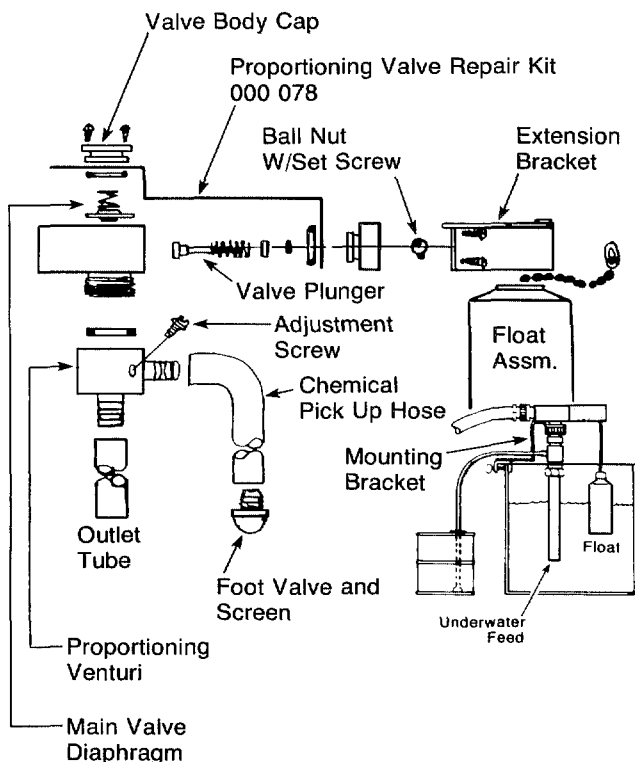
If the wand is spraying, the water will then flow to the heater. This heater has a capacity of up to 2 gallons, therefore it is extremely important that all air is bled out of the heater prior to initial start-up. This may be achieved by running the system, without the heater on, for approximately 60 seconds.

WATER FLOW



- A - Chemical Jug
- B - Pressure Gauge
- C - Chemical Flow Meter
- D - High Pressure Pump
- E - Incoming Water
- F - Tank Drain
- G - To Wand
- H - Bypass Valve
- I - Proportioner
- J - Heater Coil
- High Pressure
- Low Pressure

CHEMICAL PROPORTIONING AND LEVEL CONTROL



CHEMICAL TANK TROUBLE SHOOTING GUIDE

PROBLEM: No or Low Chemical Flow

Solution

Check that hoses in the tank are secured. Check that the hose from the top of the flow meter to the side of the mix tank is secured with no kinks. Check the hose from the bottom of the flow meter to the chemical jug for kinks or cracks.

Check the foot valve and screen on the end of the hose which goes into the mix tank. To check this screen for proper function, remove it from the plastic hose. You should be able to suck through the hose barb end, but you should not be able to blow through the hose barb end. (If you can not suck through it then rinse it out with vinegar.) When screen is removed the chemical fill hose should be lifted into a vertical position so the ball in the foot valve will seat by gravity. (This is only a temporary fix for low water pressure areas.)

Check flow meter for float obstruction.

Check to insure that the adjusting screw on proportioning venturi is backed out.

Is proportioning venturi closed? Soak in warm water or vinegar solution.

Is incoming water pressure less than 20 PSI?

Cracked or defective chemical flow meter?

NOTE: If you are in a low water pressure area and find that the volume of water entering the mix tank is not enough to allow your venturi to siphon chemical, unscrew the spring from the foot valve screen and remove the spring.

PROBLEM: Inability to Adjust Chemical with the Flow Meter

Solution

Debris lodged behind teflon seat in flow meter knob.

Teflon seat dismounting from flow meter knob.

PROBLEM: Solution Reversing from Mix Tank to Chemical Jug

Solution

Anti-siphon screen removed from chemical jug hose.

Debris in anti-siphon screen.

PROBLEM: Mix Tank Overflows

Solution

Float ball in mix tank hanging up (not moving freely).

Extension bracket pinching the float lever, restricting full action of the lever.

Plunger not seating properly on the valve. (Remove the 2 screws which hold the extension assembly to the valve. Do not lose or drop the screws. Remove the extension assembly. Turn it upside down. Inspect the plunger for proper seating. If there is no debris obstructing the valve or plunger, the plunger may be out of adjustment. To adjust, loosen the set screw on the ball nut and move the ball toward the end of the rod 1/16". Retighten set screw. Place extension assembly back into position. Tighten the two screws.

PROBLEM: Mix Tank Doesn't Keep Up With Water Output

Solution

Check garden hose quick connect assembly screen.

Check garden hose and/or feed hose to the mix tank for clog, kinks or blockage.

Float ball in mix tank hanging up. (Not moving freely.)

Extension bracket pinching float lever, restricting full action of lever.

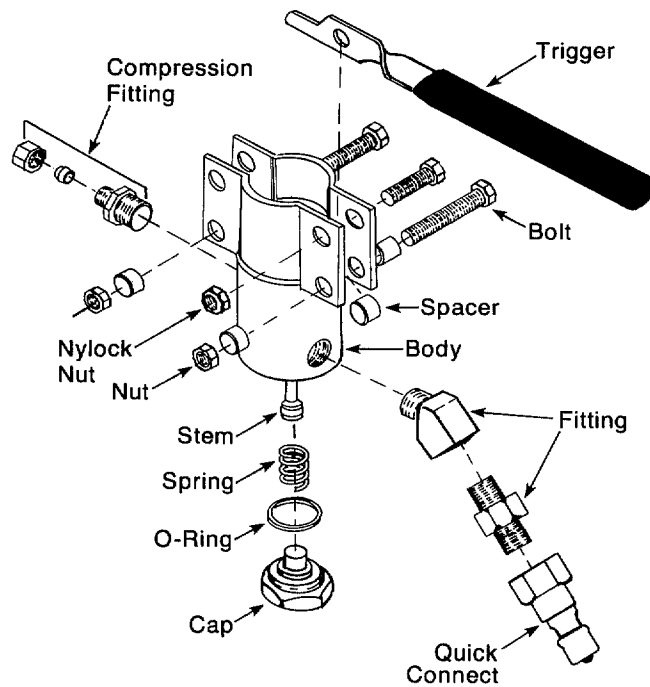
Valve plunger not opening fully. To adjust, remove the 2 screws which hold the extension assembly to the valve. (Do not lose or drop the screws.) Remove the extension assembly, turn it up side down. To adjust, loosen the set screw on the ball nut. Place your thumb on the plunger and press it in 1/16" and slide the ball nut w/set screw toward the plunger end 1/16". Tighten the set screw. Place the extension assembly back into position. If the tank starts to overflow, the ball nut is too close to the valve plunger and should be moved back away from the valve plunger slightly.

PROBLEM: Pump Pulsates When The Tank Is in a Fill Mode

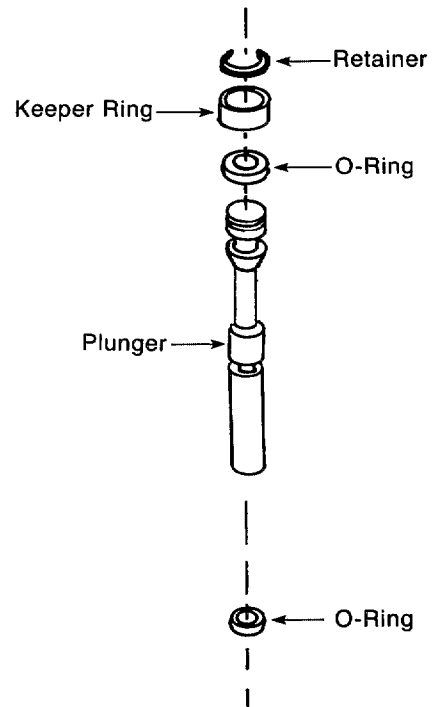
Solution

Check that the hose which goes from the gray plastic venturi to the bottom of the tank is not directed toward the Cat pump pick up port. If it is, aim it in another direction.

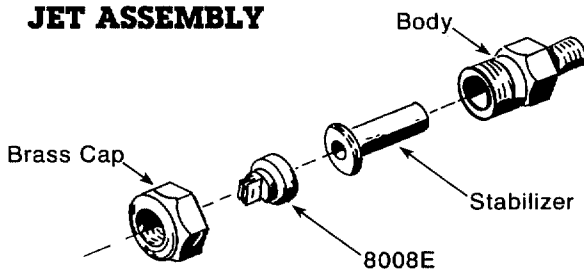
VALVE ASSEMBLY



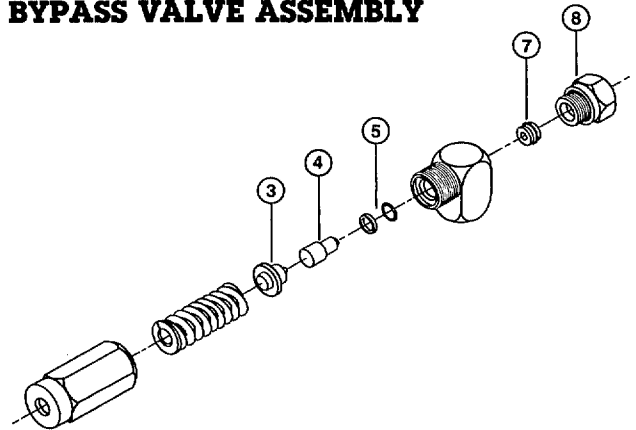
STEM ASSEMBLY



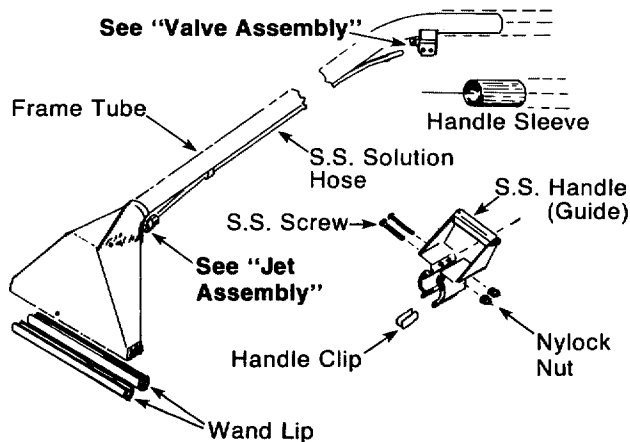
JET ASSEMBLY



BYPASS VALVE ASSEMBLY



WAND ASSEMBLY



BYPASS PARTS LIST

REF. NO.	PART NO.	DESCRIPTION	QTY.
3.	000-105-101	Thrust Plate, Bypass Valve	1
4.	000-105-102	Piston Plate, Bypass Valve	1
5.	000-078-101	Kit, Seal for Bypass Valve	1
7.	000-148-004	Seat & O-Ring, Bypass Valve	1
8.	000-097-005	O-Ring, Bypass Valve Fitting	1

FLOW WATER TROUBLE SHOOTING

PROBLEM: Loss of Pressure

Cause	Solution
Defective or blocked check valves in high pressure pump cylinder head.	Disassemble cylinder head and replace or clean applicable check valve.
Delaminated, kinked or clogged hose between the mix tank and the high pressure pump.	Remove and replace defective hose.
Defective pressure relief valve or debris in pressure relief valve. NOTE: the high pressure bypass valve is designed to fully close when the cleaning tool is turned on. Any foreign matter collecting on the piston will prevent full closure of the valve and allow a portion of the water to continue to circulate instead of being routed to the cleaning tool. To correct this situation, the bypass valve must be disassembled and cleaned (refer to drawing provided in this manual for bypass disassembly).	Disassemble and clean pressure relief valve as illustrated in drawing. Replace defective or worn out bypass cup. Replace bypass valve.
Defective or worn cups.	Remove and replace piston cups as defined by pump manual.
Loose drive belt for high pressure pump.	Readjust belt as required or replace if defective.
Loss of Pressure/Unit with clutch.	Is clutch engaged? Check tank for water.

PROBLEM: Water Flow

Cause	Solution
Worn out spray jet. NOTE: Cleaning tools designed to spray a constant flow of 1½ GPM will average 1 gallon of flow per minute in actual working situations since flow is not continuous. An average flow of 1 GPM results in 6000 gallons of flow for every 100 hours of unit operation. Spray tips are capable of constant flow rates for approximately 20,000 gallons. They should be replaced therefore, approximately every 350 hours. Worn spray jets allow a greater average rate of flow thus reducing desired temperature levels.	Remove and replace spray jet.
Reduction of Flow.	Due to increased length of solution hose . NOTE: For every 50 feet of hose, beyond 100 feet in total length, a measurable loss of flow is experienced. This condition is a result of the increased friction experienced by the water as it passes through the hose. Therefore, it is necessary to increase the pressure at the machine 40 PSI for every additional 50 feet of cleaning solution hose over 100 feet.

VACUUM SYSTEM INFORMATION

The vacuum blower incorporated in this machine is a positive displacement lobe type, manufactured by Cooper Industries. The performance and life of this unit is greatly dependent on the care and proper maintenance it receives.

Because of the close tolerances between the lobes and housing of the vacuum blower, solid objects entering the inlet will damage the internal lobes, gears and bearing or direct drive coupler.

To prevent this, a stainless steel filter screen has been placed at the vacuum inlet inside the vacuum recovery tank. This stainless steel screen is finger tight and should be removed for cleaning weekly.

CAUTION: Should be used when machine is being run for test purpose and the vacuum inlet on top of machine is open.

To protect the vacuum blower from overloading and damaging itself, there is a vacuum relief system installed on the vac tank lid. When the vacuum tank inlet is completely sealed off, a maximum of 14 HG will be attained. A hole on the top blower pipe elbow acts as the lubrication point; at the end of each day, LPS 1 or WD-40 is sprayed in before shutting down the machine. See blower lubrication illustration. If you fail to lubricate the vacuum blower daily, rust deposits and moisture will decrease the life of the vacuum blower.

Read the vacuum blower manual carefully for proper oil change and grease application. The maintenance log may differ slightly from the manual, but the truck-mounted carpet cleaning machine application is very demanding of the vacuum blower and therefore it should be maintained more regularly.

NOTICE: Vacuum tank is protected from overflowing by a vacuum tank, float kill switch.

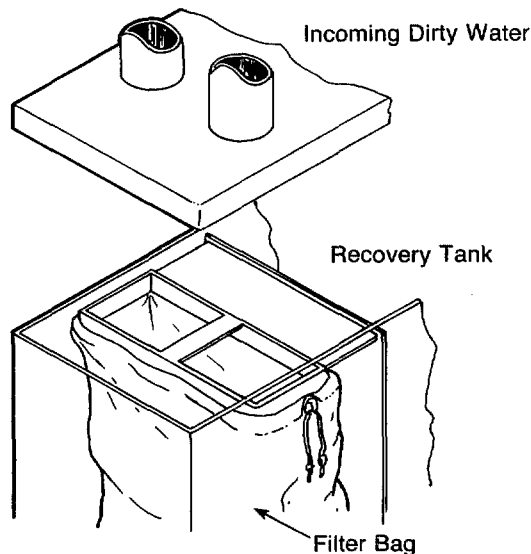
CAUTION: This switch is not activated by foam, only by liquid.

VACUUM TANK FILTER BAGS

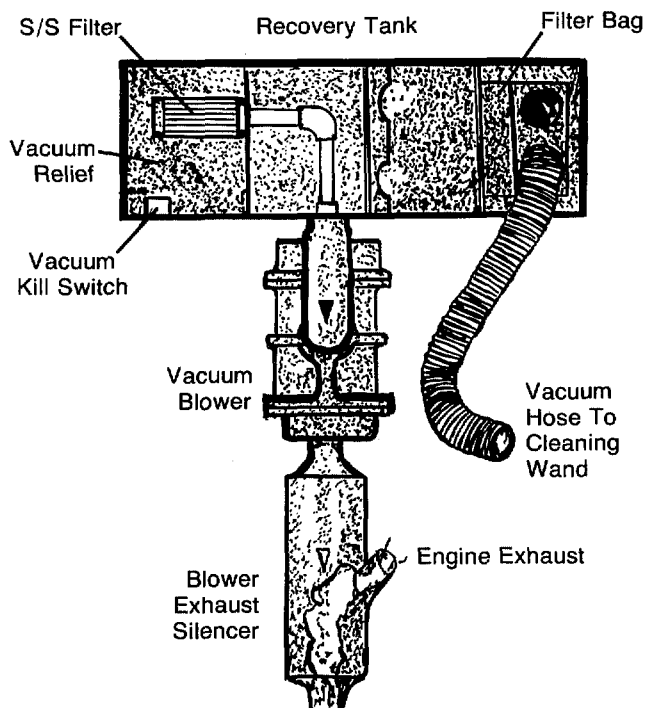
HydraMaster filter bags are designed to trap all of the lint, sand and dirt that would normally collect at the bottom of your vacuum tank. The use of these bags, if emptied at the end of each job, will eliminate the build-up of much of the debris in the tank and avoid a mess on the customer's driveway or street. The drawstring top of these bags is designed to be tied to the incoming dirty water inlet in the vacuum tank.

To reorder bags use part number 049-029.

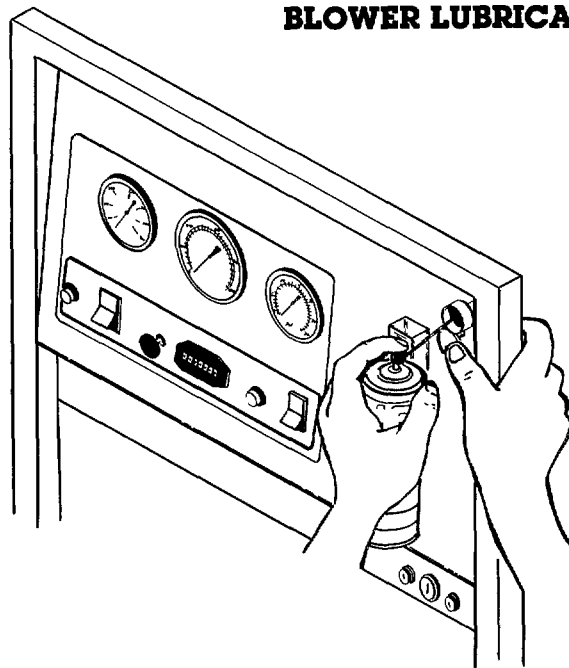
VACUUM TANK FILTER BAGS



VACUUM FLOW



BLOWER LUBRICANT



Spray lubricant into blower lube port for 3 to 5 seconds, then immediately shut off machine.

Use only LPS 1 or WD-40 moisture displacing lubricants.

VACUUM BLOWER WARRANTY

1. All Sutorbilt California Series 'F' blowers are covered by this warranty.
2. Warranty period is 24 months from date of shipment, or 18 months from date of installation, whichever occurs first.
3. Sutorbilt will replace or repair any unit covered by this warranty without regard for the cause of failure.
4. Customers claiming relief under this warranty shall issue a Purchase Order to Sutorbilt for a replacement unit.
5. Customer must obtain a Return Goods Authorization number from the factory and return blower prepaid to an Authorized Factory Repair Center, as directed.
6. On receipt of the blower a credit memo will be issued to offset the P.O. issued per (4) above.
7. Replacement unit will be shipped to customer at Sutorbilt's expense to any destination in the US or Canada.
8. SUTORBILT reserves the right to withdraw the Uncontested Warranty where evidence indicates application outside the manufacturer's stated performance area, or where there is evidence of abuse.

**CONTACT SUTORBILT FOR THE LOCATION OF THE
FACTORY AUTHORIZED SERVICE CENTER NEAREST YOU**



SUTORBILT®

SUTORBILT/INDUSTRIAL MACHINERY

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Compton, CA 90224
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Telex: 244337SUT
FAX: (213) 639-7632

VACUUM BLOWER LUBRICATION

At the gear end the timing gear teeth are lubricated by being partially submerged. The gear teeth serve as oil slingers for gear end bearings. At the drive end of the bearings are grease lubricated.

FILLING PROCEDURE

Remove square head vented oil fill plug (A) on gear end. Remove oil level plug (B) located in the head plate. Fill gear case until oil drips out of the oil level hole (B).

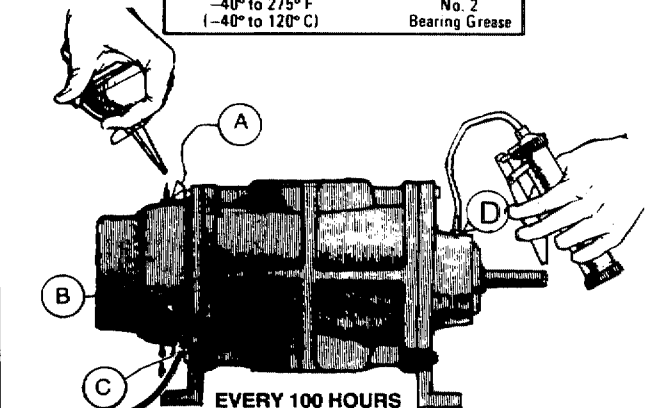
Use lubricants as listed.

Add fresh oil as required to maintain proper level. The oil should be drained, flushed and replaced every 1500 hours or more frequently if inspection so indicates. The oil drain plug is at (C).

NOTE: Older units may have the oil fill level and drain holes located in the cast iron gear case instead of in the head plate.

Bearings on drive end of blower require grease lubrication every 100 hours of operation. Bearings which require grease lubrication will have a grease fitting (D) at each bearing. When regreasing, the old grease will be forced out of the vents during operation. To prevent damage to seals, these vents must be kept open at all times.

LUBRICATION INSTRUCTIONS FOR OIL LUBRICATED GEARS AND BEARINGS		
Add fresh oil as required to maintain proper level. Drain and refill every 1500 hours of operation under normal service, more frequently when required. Use a good quality oil.		
BLOWER DISCHARGE TEMPERATURE	OIL GRADE U.S.A.*	OIL VISCOSITY CENTISTOKES @ 40° C
-40° to 32° F (-40° to 0° C)	SAE 10W	45
32° to 100° F (0° to 38° C)	SAE 20	100
100° to 275° F (38° to 135° C)	SAE 40	200
over 275° F (135° C)	SAE 50	250
*In applications with extreme variations in ambient temperature a 20W - 50W multiple viscosity oil is recommended.		
FOR GREASE LUBRICATED BEARINGS		
Service every 500 hours of operation		
BLOWER DISCHARGE TEMPERATURE	TYPE GREASE	
-40° to 275° F (-40° to 120° C)	No. 2 Bearing Grease	



VACUUM BLOWER TROUBLE SHOOTING GUIDE

PROBLEM: Loss of Vacuum

Cause	Solution
Collapsed vacuum hose between blower and vacuum tank.	Remove and replace hose. NOTE: A special reinforced hose is required for replacement.
Clogged stainless steel filter.	Remove and clean or replace stainless steel filter.
Defective vacuum tank seal.	Remove and replace vacuum tank seal.
Defective or 'open' vacuum tank dump valve.	Close valve. Replace valve.
Fractured weld on vacuum tank.	Re-weld as required or replace tank.
Collapsed or kinked vacuum hose.	Reshape hose if possible and/or eliminate kinks.
Plugged vacuum hose.	Remove obstruction by reversing the vacuum hose.
Restriction in cleaning tool.	Remove obstruction.
Worn end plates or lobes in vacuum blower.	Replace worn components. NOTE: Must be accomplished by a qualified technician.
Loose drive shaft between clutch and blower.	The set screws may come loose causing blower to stand still while engine may be turning properly. NOTE: Unless the blower is seized or making a knocking noise, your vacuum loss is not caused by a bad blower.

PROBLEM: Blower is Seized

Cause	Solution
Rust.	Spray rust dissolving lubricant onto lobes to emulsify rust and attempt to rotate vacuum lobes.
Foreign matter.	Disassemble and remove foreign matter and repair as required. NOTE: Disassembly must be accomplished by qualified technician.

NOTE: The above mentioned, rust, foreign matter and seizing are often caused from foam traveling through the blower.

PROBLEM: Noise in Vacuum Blower

Cause	Solution
Worn Gears.	Remove and replace gears. NOTE: Replacement of gears must be accomplished by a qualified technician. Timing of vacuum blower has been changed due to worn components. Replacement of components must be accomplished by a qualified technician.
Lack of Lubrication. NOTE: Permanent damage may have resulted from lack of lubrication.	Lubricate as specified by applicable vacuum blower manual. See index.
Worn bearings.	Remove and replace bearings as required. Must be accomplished by qualified technician.
Debris and/or foreign material build-up. NOTE: A stainless steel filter is provided in vacuum inlet located in vacuum blower components.	Disassemble vacuum blower and remove foreign material. NOTE: Disassembly should be accomplished by qualified technician only. Replacement of worn parts is recommended if this procedure is necessary.
Loose or missing mounting bolts.	Tighten or reinstall mounting bolts.

HEATING SYSTEM INFORMATION

The propane heater incorporated in this equipment is a special design for use in the carpet cleaning industry. It's high pressure coils and thermostatic temperature control make it simple to operate and reliable. Once the desired temperature is set, the heater will then go 'on' and 'off' according to the water temperature within the heater. As water is used through the cleaning tool, cold water entering the heater will activate the thermostatically controlled propane valve thereby firing the heater to maintain a constant flow of hot water. Once the cleaning wand is shut off and the flow of water through the heater stops, the heater will continue to burn until the set temperature is attained.

It is possible then with this design that the flame may be on when the wand is off, likewise, it is possible the flame may be off when the wand is on.

CAUTION: This heater is designed to burn **vapor** propane gas only. Any liquid propane entering the heater may cause damage to the control valve on the heater. It will also cause improper burning and a soot build-up on the coils. Therefore, it is necessary to shut off the heater and close the valve at the tank between cleaning locations. Failure to do this allows sloshing liquid to enter the vapor feed line to the heater.

IMPORTANT: Overfilling of the propane tank will cause many problems. To avoid this, advise the attendant filling the tank **not to fill the tank over 80%**. When filling the tank, watch the 10% valve and immediately stop filling when white liquid starts spurt-ing from the 10% valve. To prevent damage to the propane regulator, always close the valve on the tank before filling.

The propane regulator is pre-set at the factory at 6 oz. of propane. This reading is taken at the control valve on the heater (see figure A No. 6). To prevent road dust and moisture from entering the propane regulator, keep the white plastic cover (supplied) on the regulator at all times.

To avoid restriction of air flow at base of heater, keep articles such as chemical containers, hose, boxes, etc. from within 18 inches of base of heater. **NOTE:** This restricted situation also creates an over rich condition which results in soot build-up.

IMPORTANT: If a new propane tank has been installed or hoses have been disconnected, air may enter propane hoses and must be purged prior to attempting to light the pilot burner. Should this condition exist, operator must depress the pilot button for 1-5 minutes and attempt to ignite the pilot light at 15 second intervals. A very slight hissing noise should be evident while performing this operation.

CAUTION: Check heater for propane leaks regularly as loading and unloading hoses, tools, etc., may accidentally bump against heater fittings or pipes.

HEATER - OPERATING INSTRUCTIONS

CAUTION: Heater must be filled with water prior to igniting.

A. TO START PILOT:

1. Adjust thermostat control knob on unitrol to desired setting.
2. Adjust upper dial to pilot position.
3. Depress pilot button.
4. Depress sparking button to light pilot.

IF PILOT FAILS TO LIGHT:

- Is propane tank full?
- Is propane tank valve open?
- Has air been properly bled from propane line?

WHEN PILOT LIGHTS:

- Wait ten seconds, depressing button manually, then release button.

CAUTION: Always keep face away from main burner opening to avoid ignition flash burn.

B. TO LIGHT MAIN BURNER:

1. Turn upper knob to "on" position. Flame will come on.

If you do not get the burner to flame, the pilot has expired. You must turn upper dial to "off" position. Do not attempt to re-light the pilot for 60 seconds. To light the main burner, repeat instructions as above (TO START PILOT), 1 through 4.

OR,

Water may already be at controlled temperature.

Flame will turn off when thermostat senses maximum temperature.

C. TO ACHIEVE PROPER CARPET CLEANING TEMPERATURE:

1. Complete procedures A & B.
2. With 100' of hose, turn cleaning wand on for 5 minutes and the temperature should stabilize.
3. Once a constant temperature is established, turn cleaning wand 'off'. The flame on the heater burner should remain on for 10-15 seconds.
 - A. If the flame expires prior to 10 seconds, turn the thermostat dial to a higher reading, then repeat C 1-3.
 - B. If the flame remains lit after 15 seconds, turn the thermostat dial to a lower reading, then repeat C 1-3.

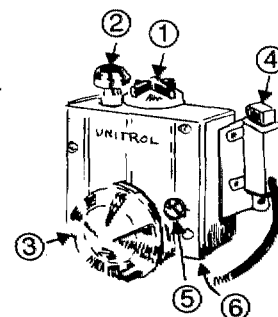
D. TO SHUT DOWN HEATER:

1. Turn upper dial #1 to 'off' position.
2. **CAUTION:** Turn cleaning wand on for 3 to 5 minutes to cool heater core. If heater core is not cooled, it is possible that the heat retained in the core will cause boiling back into a chemical mix tank.
3. Close propane tank valve while wand is on and heater is cooling.

PILOT BURNER ADJUSTMENT

1. Remove pilot adjustment cap #5.
2. Adjust pilot key to provide properly sized flame.
3. Replace pilot adjustment cap.

Allen head pipe plug #6 can be removed for monometer insertion to read propane ounces.



HEATER TROUBLE SHOOTING

**PROBLEM: Excessive Heat
Flames Proturding Outside The Lower Openings**

Cause/Solution:

1. Thermostatic control dial set too high.
A. Turn dial to lower setting.
2. Maladjustment of propane regulator. NOTE: Propane regulators are factory preset and may be readjusted by authorized personnel.
A. Contact manufacturer to determine correct procedure.
B. Have your local propane dealer use a monometer at the unitrol to reset the propane regulator to 7 oz. maximum.
3. Overfilled propane tank. NOTE: Propane heater is designed to operate on vapor propane only. Over-filling a propane tank allows liquid propane to enter all heater related components and permits an over-rich burning condition to occur. This condition usually requires the heater core to be cleaned of soot and carbon deposits. Cleaning is a messy, dirty job and very inconvenient, so don't let it happen to you!

PROBLEM: Pilot Light

Cause/Solution:

1. Pilot light will not ignite. NOTE: Do not use a needle or pin to clean pilot orifice - use compressed air or solvent only.
A. Verify propane reaching ignitor. NOTE: A kinked or crushed hose may impede propane flow.
B. Remove and clean orifice.
C. Verify ignitor spark is operating correctly.

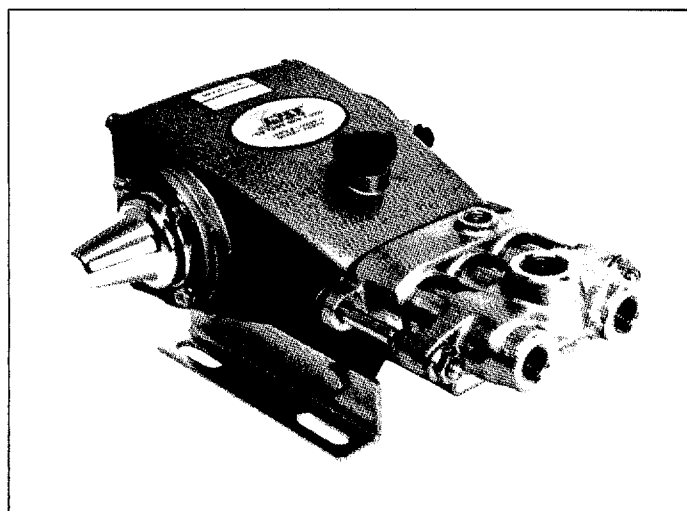


CAT PUMP Model 290 OPERATING INSTRUCTIONS

CAUTION: CAT PUMPS are positive displacement pumps. Therefore, a properly designed pressure relief mechanism **MUST** be installed in the discharge piping. Failure to install such relief mechanism could result in personal injury or damage to the pump or system. Cat Pumps Corporation does not assume any liability or responsibility for the operation of a customer's high pressure system.

SPECIFICATIONS

Volume: 3.5 GPM (13 L/M)
Discharge Pressure: 1200 PSI (83 BAR)
Maximum Inlet Pressure: -8.5 to + 40 PSI (-0.6 to + 2.8 BAR)
RPM: 1200 RPM (1200 RPM)
Bore: 0.787" (20mm)
Stroke: 0.472" (12mm)
Crankcase Capacity: 10 oz. (.3 L)
Maximum Fluid Temperature: 160°F (71°C)
Inlet Port (1): 1/2" NPT (1/2" NPT)
Chemical Injection Port (1): 1/4" NPT (1/4" NPT)
Discharge Ports (2): 3/8" NPT (3/8" NPT)
(1): 1/2" NPT (1/2" NPT)
Pulley Mounting: Either side (Either side)
Shaft Diameter: 0.650" (16.5mm)
Weight: 12.1 lbs. (5.5 kg)
Dimensions: 10.77"x9.06"x5.14" (273.5x230x130.5 mm)



Products described hereon are covered by one or more of the following U.S. patents: 3558244, 3652188, 3809508, 3920356, and 3930756



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• CAT PUMPS (U.K.) LTD. •
27 Station Industrial Estate, Fleet
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Phone Fleet 22031 — Telex 858898

CAT PUMP WARRANTY

This Cat Pump ("product") is warranted by the manufacturer to be free from defects in workmanship and material for one year from date of manufacturer's shipment. This warranty is limited to repairing or replacing products which manufacturer's investigation shows were defective at the time of shipment by the manufacturer. All products subject to this warranty shall be returned F.O.B. Cat Pumps Corp., Minneapolis, Minnesota 55430, U.S.A. for examination, repair or replacement.

The express warranty set forth herein is in lieu of all other warranties, express or implied, including without limitation any warranties of merchantability or fitness for a particular purpose and all such warranties are hereby disclaimed and excluded by the manufacturer. Repair or replacement of defective products as provided above is the sole and exclusive remedy provided hereunder and the manufacturer shall not be liable for any further loss, damages or expenses, including incidental or consequential damages, directly or indirectly arising from the sale or use of this product.

This warranty is subject to the following warranty conditions:

Important Conditions

LUBRICATION - fill crankcase to the top of oil gauge window per specifications with Cat Pump oil or equivalent SAE 40

weight hydraulic oil with antiwear and rust inhibitor additives. Change initial fill after 50 hour run-in period. Change oil every three months or at 500 hour intervals thereafter. Prrrrm-a-lube seals need no lubrication. Blue dot seals and wicks must receive three drops of Cat Pump oil per wick every 50 hours of operation.

GOOD LUBRICATION IS THE EASIEST, MOST EFFICIENT AND LEAST EXPENSIVE OF PREVENTATIVE MAINTENANCE.

RPM and PRESSURE - Pump operation must be within RPM and pressure specifications. Pressure relief valve must be installed.

DO NOT PUMP ACIDS OR ABRASIVE FLUIDS with this unit. Consult Cat Pumps for additional information on questionable fluids.

FREEZING CONDITIONS - Pump must be protected from freezing conditions.

USE OF OTHER THAN CAT PUMP PARTS OR THEIR EQUIVALENT VOIDS THE WARRANTY

GENERAL INFORMATION FOR CAT PUMP REPAIR

As you remove your discharge manifold, there is a set of 3 check valves (which usually fall out during dis-assembly). If the surfaces of these check valves are dirty, or show signs of chemical build-up, it is probable that they would remain open causing pressure loss or pulsation. Upon inspecting the valves, make sure that the teflon buttons in the valve spring retainers are still intact. Also examine the discharge manifold. Look for problems such as cracks, chemical buildup or warpage due to freezing. If this discharge manifold is warped, it will cause the check valves to stick and will result in loss of pressure.

The Cat pump cups are often the source of pressure loss. Upon inspection they may appear melted or torn, but often they will look good. Replace them anyway. There is no sure method of visually inspecting the cups. HydraMaster recommends changing cups whether they look good or not.

Anytime your pump is being dismantled, HydraMaster recommends replacement of all 'o' rings and seals. This is merely a convenience to the customer to make sure that the Cat pump is in top operating condition.

The prrm-a-lube seals located within the intake manifold will allow air to enter the pump if they are worn. Again, it is difficult to visually pinpoint a defective prrm-a-lube seal. Replace them all.

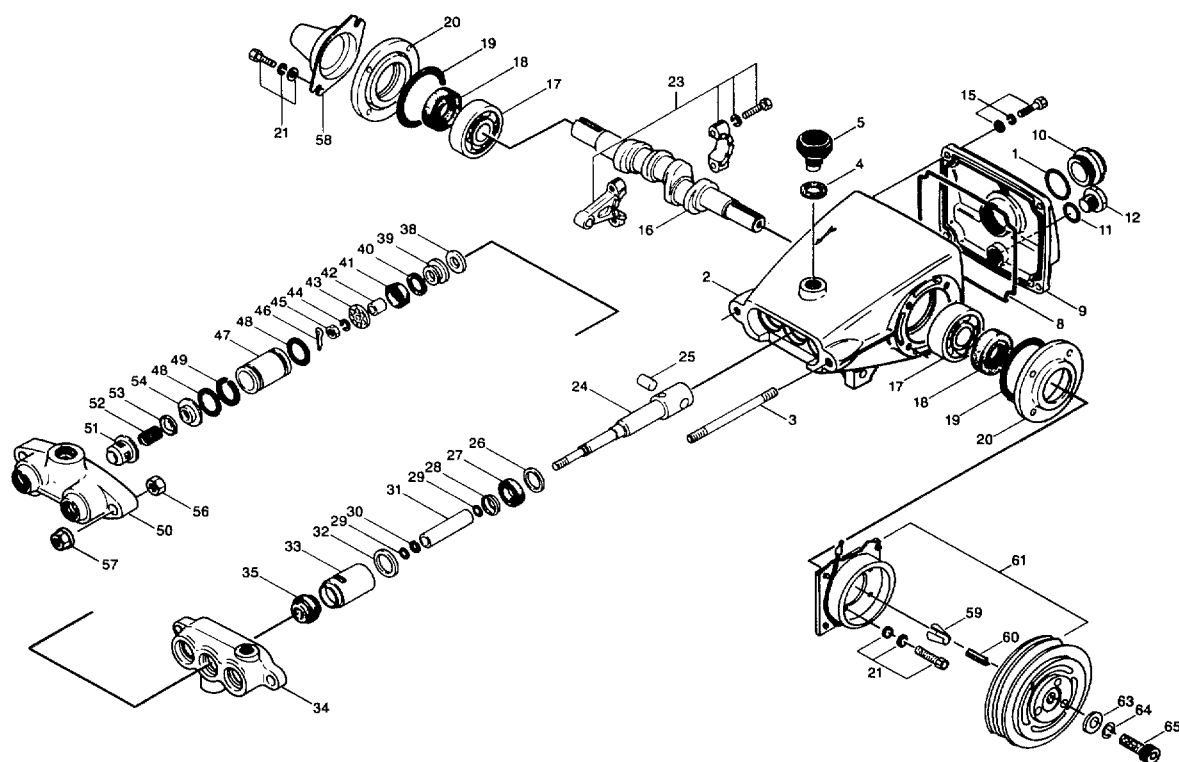
Within the piston sleeve cylinders there are 6 'o' rings that are about ¼ the size of a penny. If these 'o' rings are bad, water will be pumped back into the oil. If this has occurred the oil will raise in level and appear milky. If you are unable to repair seals right away, change oil frequently. Repair the pump as soon as possible so as to not damage bearing or connecting rods.

Repairing of Cat pumps is not a difficult task. However, before disassembling make sure you have the proper parts required.

1 - short (or hot) cup kit	3 - Prrrm-a-lube seals
6 - piston sleeve 'o' rings	1 - bottle Cat oil

Read instructions thoroughly, supplied in the Cat pump manual, prior to disassembly and follow directions as stated. Oil all seals thoroughly prior to installation. (Remember, a newly scarred seal is no better than one you just took out.)

PISTON MODEL 290 Exploded View



PARTS LIST Model 290

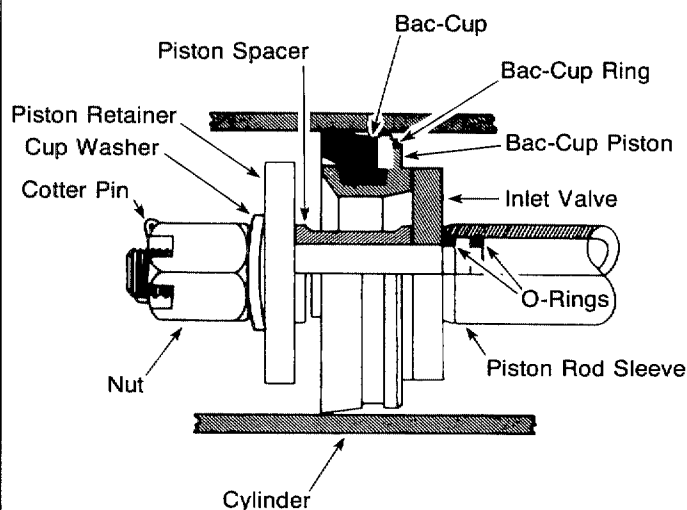
ITEM	PART NO.	DESCRIPTION	QTY.
1	20285	O-Ring (Buna-N)	1
2	44274	Crankcase	1
3	85680	Stud (M8 x 82)	2
4	44377	O-Ring, Oil Filler Cap	1
5	44374	Oil Filler Cap	1
8	43340	O-Ring, Crankcase Cover	1
9	43339	Crankcase Cover	1
10	43987	Bubble Oil Gauge	1
11	23170	O-Ring, Drain Plug	1
12	25625	Drain Plug	1
15	92520	Sems Comb Head Screw (M6 x 20)	6
16	43804	Crankshaft	1
17	14487	Rearing	2
18	24159	Oil Seal (Buna-N)	2
19	26536	O-Ring, Oil Seal Case	2
20	27950	Oil Seal Case	2
21	92519	Sems Comb, Head Screw (M6 x 16)	8
23	101799	Connecting Rod	3
24	101800	Piston Rod	3
25	16948	Piston Pin	3
26	20017	Seal Washer	3
27	25301	Oil Seal	3
28	25327	Barrier Slinger	3
29	25392	O-Ring, Sleeve	3
	28771	O-Ring, Sleeve (Viton)	3
30	29003	Back-Up Ring, Sleeve (Teflon)	3
31	29614	Sleeve (29743 Unchromed)	3
32	26854	Seal Washer	3
33	28597	Seal Retainer	3
34	25128	Inlet Manifold	1
	25635	Inlet Manifold-Stainless Steel	1

ITEM	PART NO.	DESCRIPTION	QTY.
35	30315	Prrrrrm-A-Lube Seal	3
	30325	Prrrrrm-A-Lube Seal (Viton)	3
38	27004	Inlet Valve	3
39	30543	Bac-Cup Piston	3
40	30544	Bac-Cup Ring (Teflon)	3
41	43172	Cup (Viton)	3
	43474	Bac-Cup Assembly	3
42	27983	Piston Spacer	3
43	27002	Piston Retainer	3
44	27006	Conical Washer-SS (M6)	3
45	27000	Nut-SS (M6)	3
46	14158	Cotterpin	3
47	101802	Cylinder (43834 Unch)	3
48	23172	O-Ring, Cylinder (Buna-N)	6
	11377	O-Ring, Cylinder (Viton)	6
49	21985	Bac-Up Ring, Cylinder	3
50	24459	Discharge Manifold	1
	25634	Discharge Manifold-S.S.	1
51	43442	Valve Spring Retainer	3
52	43360	Valve Spring	3
53	43723	Valve	3
54	43434	Discharge Valve Seat	3
56	81109	Hex Nut (M8)	2
57	101804	Hex Flange Nut (M8)	2
58	25130	Shaft Protector	1

Electric Clutch Assembly

59	152-005	Tapered Sleeve	1
60	077-005	Key, Electric Clutch	1
61	036-005	6" Electric Clutch	1
62	143-084	8-30 mm Socket Head Screw	1
63	174-004	Flat Washer (5/16 US)	1
64	174-018	Lock Washer (5/16 US)	1

PUMPING SECTION CUTAWAY



078-001 Cup Kit

- 3 Cup
- 6 O-Ring, Cylinder
- 3 Cotterpin
- 1 Instruction Sheet
- 1 Cup Inserter

078-003 Seal Kit

- 3 Prrrrm-A-Lube Seal
- 3 Cotterpin
- 2 Abrasive Paper
- 1 Instruction Sheet

30431 Sleeve and Seal Kit

- 3 Prrrrm-A-Lube Seal
- 3 Barrier Slinger
- 3 Cotterpin
- 3 Sleeve
- 6 O-Ring, Sleeve
- 1 Instruction Sheet

078-006 Valve Kit

- 3 Valve Spring Retainer
- 3 Valve Spring
- 3 Valve
- 3 Valve Seat
- 3 O-Ring, Cylinder
- 1 Instruction Sheet

30860 Piston Kit

- 6 O-Ring, Cylinder
- 3 Back-Up Ring, Cylinder
- 3 Bac-Cup Piston
- 3 Bac-Cup Ring
- 3 Cup
- 3 Piston Spacer
- 3 Piston Retainer
- 3 Conical Washer (M6)
- 3 Nut (M6)
- 3 Cotterpin
- 3 Inlet Valves
- 1 Instruction Sheet

SERVICING THE VALVE ASSEMBLIES

DISASSEMBLY

1. Remove the fasteners securing the discharge manifold to the crankcase of the pump.
2. Support the discharge manifold and tap from the backside and a soft mallet to separate from the crankcase and gradually work free from cylinders.
3. Valve assemblies will remain in the manifold. **Pump models with the o-ring groove on the outside of the valve seat require the assistance of a reverse pliers to remove the valve seat.** The valve, spring and retainer will then fall out when the manifold is inverted.

Pump models without the o-ring groove on the outside of the valve seat permit the seat, valve, spring and retainer all to fall out when manifold is inverted.

REASSEMBLY:

1. Place retainers in manifold chambers.
2. Next insert spring into center of retainer.
3. Inspect the valves for wear, ridges or pitting and replace if necessary.

NOTE: Seating side of flat valves may be lapped on flat surface using 240 grit paper. Quiet valves due to their shape must be replaced.

Insert valve over spring with recessed (dish) side down.

4. Next examine the seating surface of the flat valve seats and lap with 240 grit paper or replace if evidence of excessive wear. Quiet valve seats should be replaced if worn. Lap new quiet valve and seat to assure positive seal.
5. Some pump models have o-rings and back-up rings on the valve seat. Examine and replace if worn. Always lubricate o-rings for ease of installation and to avoid damaging elastomers.

NOTE: First install o-ring in groove on seat (towards seating surface), then back-up ring.

NOTE: Models without outer groove on seat require the o-ring to be placed on lip of retainer.

6. Insert valve seats into manifold chambers.
7. Position manifold back onto pump.

NOTE: Lubricate o-rings on cylinder and exercise caution when slipping manifold over cylinders to avoid damaging cylinder o-rings.

8. Replace fasteners and torque per specification chart.

NOTE: Replace all original shims when used. When new manifold is used reshim pump.

CAUTION: When starting the pump, check to see that there is no cylinder motion as this will cause premature failure of the cylinder o-rings. Center cylinder motion can be eliminated by switching with one of the end cylinders.

SERVICING THE PUMPING SECTION

DISASSEMBLY:

1. Remove discharge manifold as described.
2. Grasp cylinders by hand and with an up and down motion, pull cylinders from inlet manifold.
3. Remove cotterpin, nut, and washer from piston rod.
4. Next remove retainer, spacer, and piston/cup assembly.
5. Remove inlet valve.

REASSEMBLY:

1. Examine inlet valve surfaces for pitting, scale or grooves. Reverse valve and sand inlet side of valve using 240 grit paper for clean surface or replace if evidence of excessive wear. Slip onto rod.
2. Examine piston seating surfaces and sand clean on flat surface using 240 grit paper. If extreme pitting or sharp edges, replace piston.

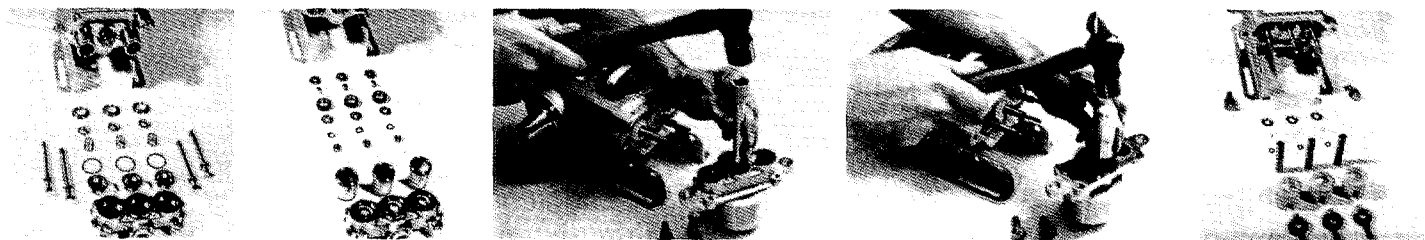
3. Examine cup for wear, cracking, tearing or separation from the piston. If worn replace and lubricate before installing on piston.

NOTE CUP INSTALLATION: Wipe cup inserter with oil. Slip bac-cup ring (when used) onto piston. Push cup over inserter and square with all surfaces. Faulty cup installation causes premature cup failure.

4. Next replace piston spacer and retainer on rod.
5. Replace washer, thread on nut and torque per specification chart.

NOTE: Always replace with new Stainless Steel Cotterpin and turn ends under.

6. Examine cylinder walls for scoring or etching which causes premature wear of cups and replace if worn.
7. Lubricate cylinder walls for scoring or etching which causes premature wear of cups and replace if worn.
8. Position discharge manifold onto pump, replace fasteners and torque per specification chart.



SERVICING SLEEVES AND SEALS

DISASSEMBLY:

1. Remove discharge manifold and piston assemblies as described.
2. Remove inlet manifold containing seals.
3. Grasp sleeves and with a pulling and twisting motion remove the sleeves from the piston rod.
NOTE: Grasp sleeve with pliers only if replacing worn sleeves, as this procedure will mar the sleeves.
4. Next remove seal retainer.
5. Remove and examine o-rings and/or back-up rings on piston rod for wear and replace.

REASSEMBLY:

1. Lubricate new o-rings and/or back-up rings and slip onto piston rod. Install the first o-ring in the groove on the piston rod. Next position back-up ring against the shoulder in front of the first o-ring. Then install the second o-ring. Exercise caution as you slip the o-ring over the thread end of the piston rod.
2. Examine sleeves for scoring or etching and replace. Immerse sleeves in oil and carefully twist and push sleeve onto rod (machined counter bore end first).
3. Next install seal retainers. If wicks are used, replace wicks, thoroughly saturate with oil, place in seal retainer and install retainer.
4. Place inlet manifold on pair of clearance blocks with crankcase side down and drive out old seals.

5. Invert inlet manifold with crankcase side up and install new seals. Lubricate circumference of seal and install Prrrrm-A-Lube seal with garder spring down. If using blue dot seal, blue dot should be facing up when installed.

6. Slip lubricated seal inserters onto piston rod ends, position inlet manifold onto pump and remove seal inserters.

NOTE: Replace original quantity washers on studs before replacing inlet manifold.

NOTE: Some models secure inlet manifold to crankcase. Replace fasteners and torque per specification chart.

7. Reassemble piston assemblies and discharge manifold as described.

SERVICING CRANKCASE SECTION

1. While inlet manifold, sleeves and seal retainers are removed, examine crankcase seals for wear.
2. Check oil level and for evidence of water in oil.
3. Rotate crankshaft by hand to feel for smooth bearing movement.
4. Examine crankshaft oil seal externally for drying, cracking or leaking.
5. Consult factory or your local distributor if crankcase service is evidenced.

CAT PUMP TROUBLE SHOOTING GUIDE

PROBLEM: Pulsation

Cause	Solution
Debris in discharge valves of pump.	Clean or replace discharge valves.

PROBLEM: Low Pressure

Cause	Solution
Worn nozzle.	Replace nozzle, of proper size.
Belt Slippage.	Tighten or replace; use correct belt.
Air leak in inlet plumbing.	Disassemble, reseal, and reassemble.
Pressure gauge inoperative or not registering accurately.	Check with new gauge; replace worn or damaged gauge, P.N. 06090
Relief valve stuck, partially plugged or improperly adjusted; valve seat worn.	Clean, and adjust relief valve; check for worn and dirty valve seats. Kit available.
Inlet suction strainer clogged or improper size.	Clean. Use adequate size. Check more frequently.
Worn piston assembly. Abrasives in pumped fluid or severe cavitation. Inadequate water supply.	Install proper filter. Suction at inlet manifold must be limited to lifting less than 20 feet of waer or -8.5 PSI vacuum.
Fouled or dirty inlet or discharge valves.	Clean inlet and discharge valve assemblies.
Worn inlet or discharge valves.	Replace worn valves, valve seats.
Leaky discharge hose.	Replace discharge hose.

PROBLEM: Pumps runs extremely rough, pressure very low

Cause	Solution
Restricted inlet or air entering the inlet plumbing.	Proper size inlet plumbing; check for air tight seal.
Inlet restrictions and/or air leaks. Damaged cup or stuck inlet or discharge valve.	Replace worn cup or cups, clean out foreign material, replace worn valves.
Worn inlet manifold seals.	Replace worn seals.

PROBLEM: Cylinder O-rings blown next to discharge manifold

Cause	Solution
Pressures in excess of rated PSI.	Check for plugged nozzle, closed valves or improperly adjusted by-pass valve.
Warped manifold.	Replace manifold.

PROBLEM: Leakage at the cylinder O-rings at the discharge manifold and black, powdery substance in the area of the O-rings

Cause	Solution
Loose cylinders. Cylinder motion caused by improper shiming of the discharge manifold.	Remove spacer shims on manifold studs. Do not remove too many shims or the ears of the manifold will be bowed when the manifold is retightened, causing looseness in the center cylinder.

PROBLEM: Water leakage from under the inlet manifold

Cause	Solution
Worn inlet manifold seals. Leaking sleeve O-ring.	Install seals. If piston rod sleeves are scored, replace sleeves and sleeve O-rings.

PROBLEM: Oil leak between crankcase and pumping section

Cause	Solution
Worn crankcase piston rod seals.	Replace crankcase piston rod seals.
Excess oil from wicks.	Reduce quantity of oil per oiling.

PROBLEM: Oil leaking in the area of Crankshaft

Cause	Solution
Worn crankshaft seal or improperly installed oil seal retainer packing.	Remove oil seal retainer and replace damaged gasket and/or seals.
Bad bearing.	Replace bearing.

PROBLEM: Excessive play in the end of the crankshaft pulley

Cause	Solution
Worn main ball bearing from excessive tension on drive belt.	Replace ball bearing. Properly tension belt.

PROBLEM: Water in crankcase

Cause	Solution
May be caused by humid air condensing into water inside the crankcase.	Change oil at 3 month or 500 hour intervals using Cat Pump Crankcase Oil (other approved oil every month or 200 hours) P.N.: 06100.
Leakage of manifold inlet seals and/or piston rod sleeve O-ring.	Replace seals, sleeve and O-rings.

PROBLEM: Oil leaking from underside of crankcase

Cause	Solution
Worn crankcase piston rod seals.	Replace seals, sleeve and O-rings.

PROBLEM: Oil leaking at the rear portion of the crankcase

Cause	Solution
Damaged or improperly installed oil gauge or crankcase rear cover O-ring, and drain plug O-ring.	Replace oil gauge or cover O-ring, and drain plug O-ring.

PROBLEM: Oil leakage from drain plug

Cause	Solution
Loose drain plug or worn drain plug O-ring	Tighten drain plug or replace O-ring.

PROBLEM: Loud knocking noise in pump

Cause	Solution
Pulley loose on crankshaft.	Check key and tighten set screw.
Broken or worn bearing.	Replace bearings.

PROBLEM: Frequent or premature failure of the inlet manifold seals

Cause	Solution
Scored rods or sleeves.	Replace rods and sleeves.
Over pressure to inlet manifold.	Reduce inlet pressure per instructions.

PROBLEM: Short cup life

Cause	Solution
Damaged or worn chrome plating of the cylinders.	Replace cylinders.
Abrasive material in the fluid being pumped.	Install proper filtration on pump inlet plumbing.
Excessive pressure and/or temperature of fluid being pumped.	Check pressures and fluid inlet temperature; be sure they are within specified range.
Over pressure of pumps.	Reduce pressure.
Running Pump dry.	Do not run pump without water.
Front edge of piston sharp.	Replace with new piston.
Chrome plating of cylinders damaged causing excessive wear of cups. May be caused by pumping acid solution.	Install new cups and cylinders. Pump only fluid compatible with chrome.

PROBLEM: Strong surging at the inlet and low pressure on the discharge side

Cause	Solution
Foreign particles in the inlet or discharge valve or worn inlet and/or discharge valves.	Check for smooth lap surfaces on inlet and discharge valve seats. Discharge valve seats and inlet valve seats may be lapped on a very fine oil stone; damaged cups and discharge valves cannot be lapped but must be replaced.

HYDRA-CAT ELECTRICAL SYSTEM

The entire electrical system operates on 12 volts DC which is provided by a battery. Battery levels are sustained by a 15 amp alternator designed within the engine.

NOTE: When new battery is installed insure it is properly charged before installation or damage to the charging regulator may occur.

PROBLEM: Low Battery Voltage

Cause

Defective battery.
Corroded battery terminals.
Low battery fluid.
Loose wiring within electrical system.

Solution

Remove and replace.
Clean terminals and battery posts.
Add water to appropriate level.
Examine all terminal connections and verify that they are secure.
Examine electrical systems for bare wires.
Examine terminal and remove corrosion if necessary.

PROBLEM: Inoperative Hour Meter

Cause

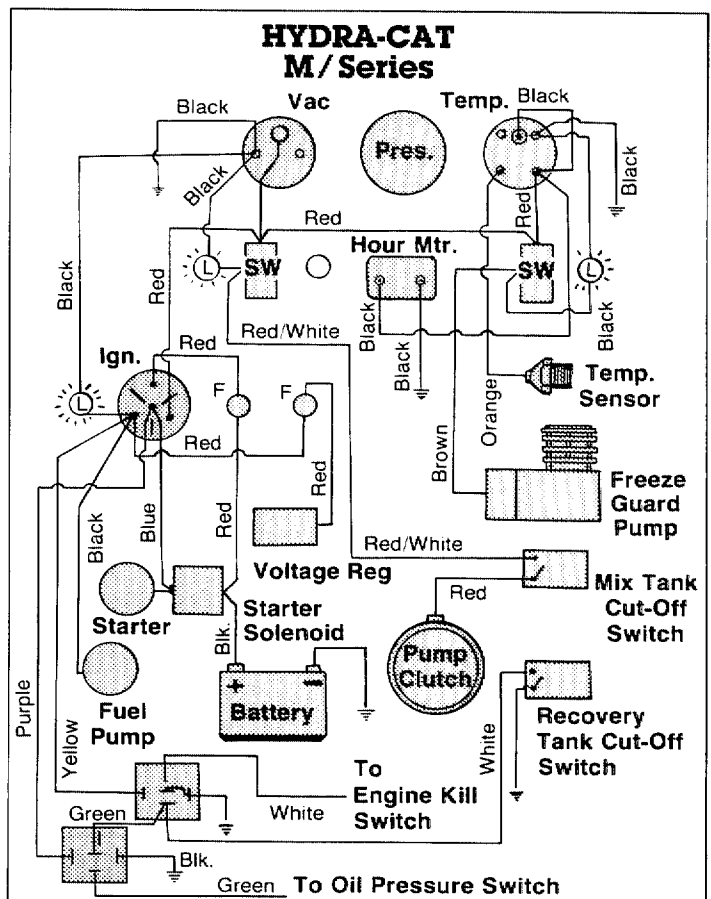
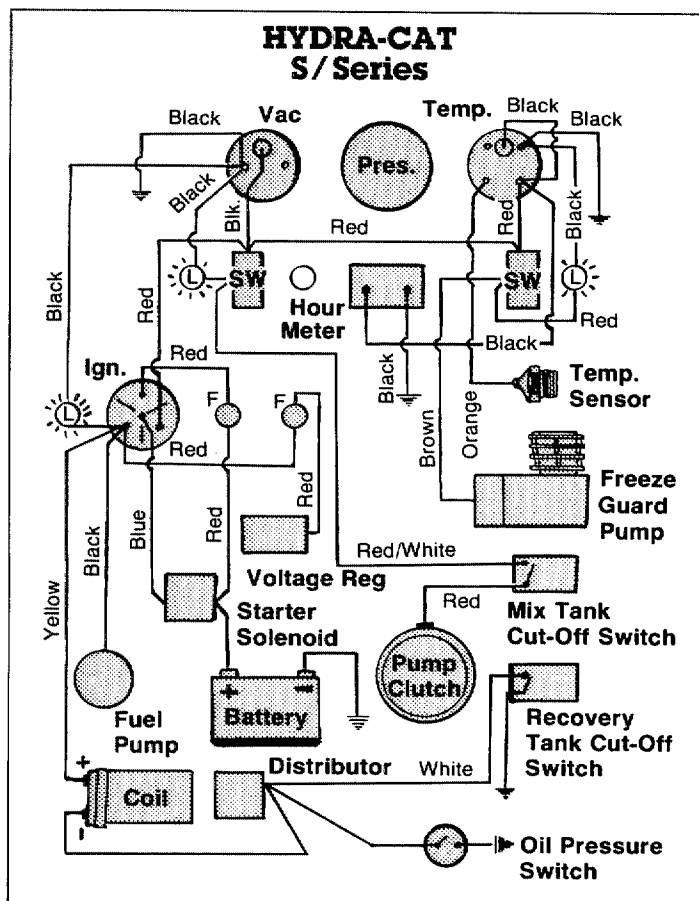
Time is not advancing correctly.

Solution

Verify 12 volts DC is available at the hour meter with the ignition switch turned on. This can be accomplished with a volt meter or a test lamp.

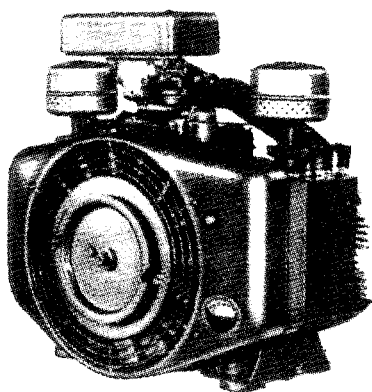
Remove and replace hour meter if 12 volts is available.

A nylon gear within the clock may have been jammed due to a sudden jolt of the machine or truck. You may try simply tapping on the meter to try to free the nylon gear.



CCKB ENGINE SERVICE GUIDE

Onan Model HydraCat S/Series



SPECIFICATIONS

Engine Design: Opposed two cylinder, four cycle, L head and air cooled

Bore: 3¼" (82.55 mm)

Stroke: 3" (76.20 mm)

Displacement: 49.8 cu inch (816.22 cm³)

H.P. - Garden Tractor Service: 19½ hp at 3600 rpm; 20 hp max. at 3900 rpm

Oil Capacity with Filter Change: 4 qts. (3.78 lit)

Oil Capacity without Filter Change: 3½ qts. (3.31 lit)

Tune-Up Specifications

Spark Plug Gap (Gasoline): .025 (0.69 mm)

Spark Plug Gap (LPG): .018 (0.46)

Breaker Point Gap: .020 (0.51)

Valve Lash:

Intake: .006 to .008 (0.152 to 0.203 mm)

Exhaust: .015 to .017 (0.381 to 0.432 mm)

Ignition Timing:

Standard Electric Start (Stopped or Running) 20°BTC

Manual Start with Spark Advance: 1°ATDC (Stopped)

24°BTC (Running)

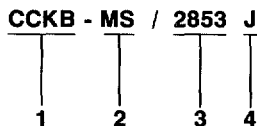
Electric Start with Magneto and Spark Advance: 5° (Stopped)

24°BTC (Running)

Engine Model Reference

Identify your model by referring to the MODEL and SPEC (specification) NO. as shown on the unit nameplate. Always use this number and the engine serial number when making reference to your engine.

How to Interpret MODEL and SPEC NO.



1. Factory code for general identification purposes.
2. Specific Type:
S - MANUAL STARTING
MS - ELECTRIC STARTING
3. Factory code for optional equipment supplied.
4. Specification (Spec Letter) advances with factory production modification.

If your engine needs service or repair, contact an Onan Service Center. Trained mechanics will assure expert repair service on your Onan engine.

OUT OF SERVICE PROTECTION

Protect an engine that will be out-of-service for more than 30 days as follows:

1. Run engine until thoroughly warm (5 to 10 minutes).
2. Turn off fuel supply and run until engine stops.
3. Drain oil from oil base while still warm. Refill and attach a warning tag stating oil viscosity used.
4. Remove spark plugs. Pour one ounce (two tablespoons) of rust inhibitor (or SAE #50 oil) into the cylinders. Crank engine over a few times. Install spark plugs.
5. Service air cleaner.
6. Clean governor linkage and protect by wrapping with a clean cloth.
7. Plug exhaust outlet to prevent entrance of moisture, dirt, bugs, etc.
8. Wipe entire unit. Coat rustable parts with a light film of grease or oil.
9. Provide a suitable cover for the entire unit.
10. If battery is used, disconnect and follow standard battery storage procedure.

WARNING: Carbon monoxide is an odorless, colorless gas formed by incomplete combustion of hydrocarbon fuels. Carbon monoxide is a dangerous gas that can cause unconsciousness and is potentially lethal. Some of the symptoms or signs of carbon monoxide inhalation are:

- Dizziness
- Intense Headache
- Weakness and Sleepiness
- Vomiting
- Muscular Twitching
- Throbbing in Temples

If you experience any of the above symptoms, get out into fresh air immediately.

The best protection against carbon monoxide inhalation is a regular inspection of the complete exhaust system. If you notice a change in the sound or appearance of exhaust system, shut the unit down immediately and have it inspected and repaired at once by a competent mechanic.

PRE-START

Before Starting

Check the engine to make sure it has been filled with oil and fuel. The chart below lists oil and fuel recommendations.

CRANKCASE OIL: Fill the crankcase with a good quality oil that meets the API (American Petroleum Institute) service designation SE or SE/CC. Recommended oil numbers for expected ambient temperatures are as follows:

TEMPERATURE	GRADE
Below 0°F (18°C)	SAE 5W30
Below 32°F (0°C)	SAE 5W30 or 10W40
Above 32°F (0°C)	SAE 30

Fill to "Full" mark on dipstick.

CAUTION: Do not overfill crankcase. Do not use service DS oil. Do not mix brands nor grades of motor oil.

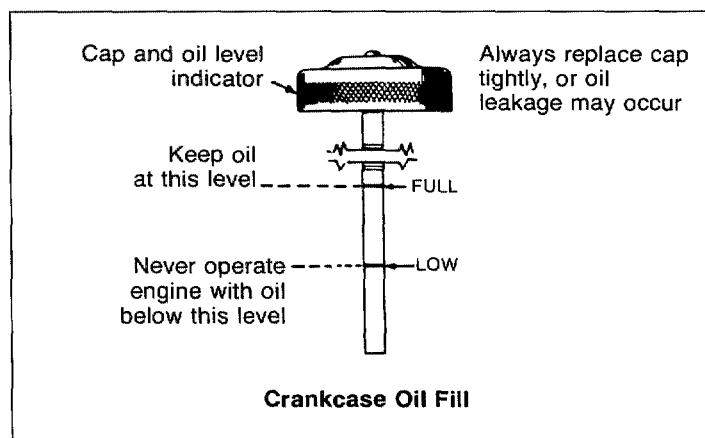
Refer to Periodic Service section for recommended oil change intervals.

RECOMMENDED FUEL: Use clean, fresh, non-leaded or regular grade, automotive gasoline. Do not use highly leaded premium types.

For new engines, the most satisfactory results are obtained by using unleaded gasoline. For older engines that have previously

used leaded gasoline, heads must be taken off and all lead deposits removed from engine before switching to unleaded gasoline.

WARNING: Never check oil level while engine is running. Hot oil discharged from the engine could cause personal injury.



CAUTION: If lead deposits are not removed from engine before switching from leaded to unleaded gasoline, preignition could occur, causing severe damage to the engine.

WARNING: Never fill the fuel tank when the engine is running. Gasoline could ignite, causing a serious injury.

INSPECTION: Inspect the engine visually before starting. Check for loose or missing parts and any damage which may have occurred in shipment.

STARTING

If your engine has a START-RUN-STOP switch, press switch toggle to START, then release to RUN when engine starts. Press toggle to STOP, to stop engine.

1. Turn on ignition switch, pull the choke lever way out (for a cold engine) and push the start switch. When the engine starts, gradually push the choke lever in until the engine runs smoothly.
2. Black smoke from the exhaust and a rough running engine usually indicate over-choking.
3. To stop engine, turn ignition switch to off position.

OPERATION

Break-in Procedure

Controlled break-in with proper oil and a conscientiously applied maintenance program will help assure satisfactory service for many hours from your Onan engine.

Break-in or ideal fitting of all internal moving metal parts can best be achieved by maintaining proper cooling and correct lubrication during the running-in period. Run the engine at about half load for the first three hours with intermittent periods of full load to control engine break-in. Engine damage can be caused by using the wrong grade and weight of oil and high engine operating temperatures during break-in.

Check the oil level at least every five operating hours. Add oil to keep it at the proper level, but never overfill as overfilling may cause the oil to foam and enter the breather system.

Hot Weather Operation

When operating the engine in temperatures above 75°F (24° C) pay particular attention to the following items to prevent damage:

1. Keep the engine cooling fins clean and free of obstruction which would decrease air flow to and from the engine.
2. See that nothing obstructs air flow to and from the engine.
3. Ensure that you are using the proper grade and weight of oil for the temperature the engine is being used in. Check the oil level each time you fill the fuel tank.
4. Check the battery water level more frequently than every 50 hours which is recommended under normal conditions. High temperatures cause faster evaporation.

Cold Weather Operation

When the engine is being used in temperatures below 32°F (0° C), check the following items closely:

1. Use the correct grade and weight of oil for the temperature conditions. Change the oil only when the engine is warm. If an unexpected temperature drop occurs when the engine is filled with summer oil, move to a warm location until the oil will flow freely before starting the engine.
2. Use fresh fuel. Fill the fuel tank after each days use to protect against moisture condensation.
3. Keep battery in a well-charged condition.

MAINTENANCE

OIL LEVEL: Check oil level at least every eight hours of operation. Check more frequently on a new or overhauled engine as oil consumption is higher until piston rings seat properly.

OIL CHANGE: Change crankcase oil after the first 25 hours of operation; change every 50 hours after that. If operating in extremely dusty conditions, change oil more frequently.

OIL FILTER (If used): Replace oil filter every 100 hours; replace more often in dusty conditions. Tighten the filter finger-tight plus one quarter to one half turn. Be sure to replace rubber ring around filter.

CRANKCASE BREATHER: This engine uses a crankcase breather valve for maintaining crankcase vacuum. No maintenance is generally required. If the crankcase becomes pressurized as evidenced by oil leaks at the seals, clean the crankcase breather cap and valve assembly, and the breather tube baffle in suitable solvent. To remove breather cap and valve assembly, remove the breather hose clamp and breather tube clamp.

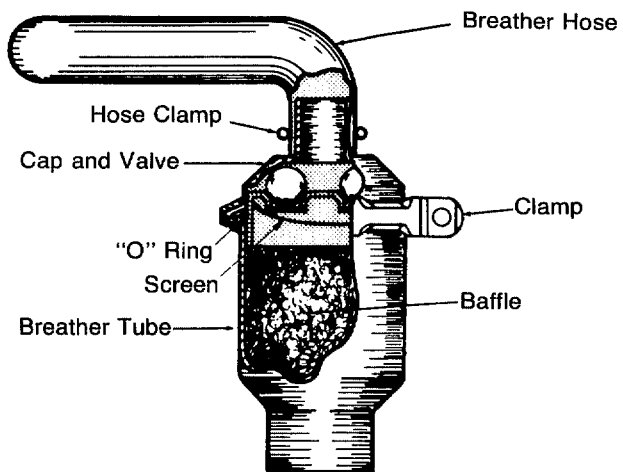
MOISTENED FOAM AIR CLEANER: This air cleaner consists of a synthetic sponge over a metal retainer. The base and cover are similar to those of the dry paper kind. Wash the sponge periodically, moisten in oil and squeeze dry.

COOLING SYSTEM: Check and clean cooling fins at least every 50 hours. Remove any dust, dirt or oil which may have accumulated.

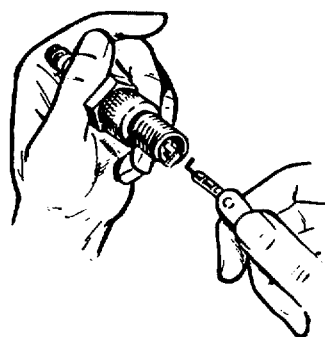
CAUTION: Plugged or clogged cooling fins can cause overheating and engine damage.

SPARK PLUGS: Check, clean and reset spark plugs every 100 operating hours. Replace spark plugs that show signs of fouling or electrode erosion. Replace plugs every 250 operating hours.

BREAKER POINTS: Check, clean and reset breaker points every 200 operating hours. Replace points if they are pitted or burned. See ADJUSTMENT section.



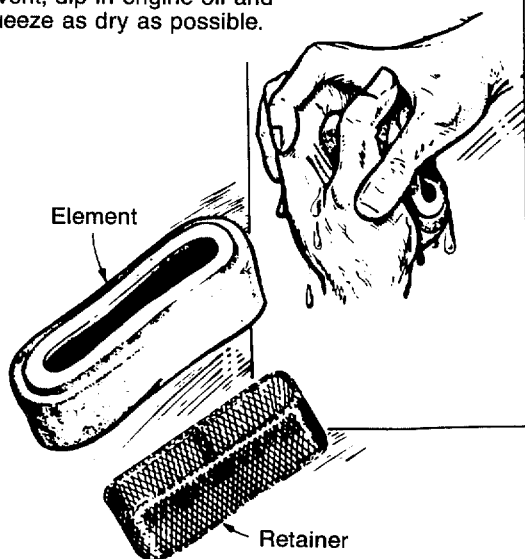
Crankcase Breather



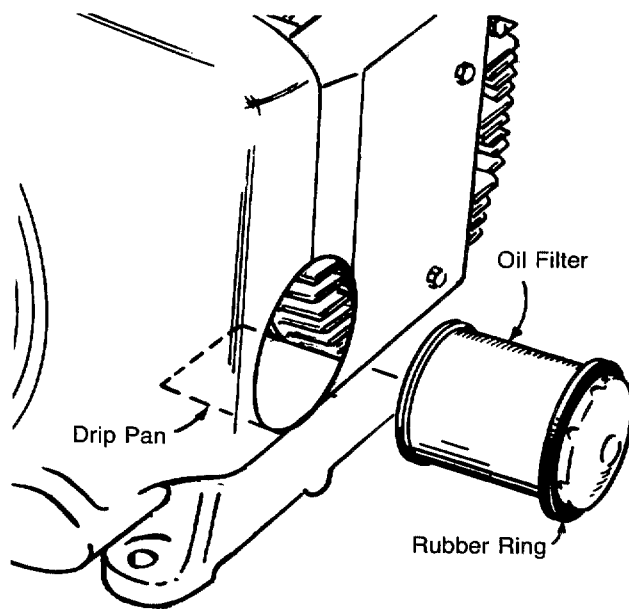
Spark Plug Gap 0.025"

Spark Plug Gap

After washing element in solvent, dip in engine oil and squeeze as dry as possible.



Air Cleaner



Oil Filter

ADJUSTMENTS

CARBURETOR

The carburetor has an idel jet and a main jet. The idle jet which is adjustable, effects engine operation at low speed. The main jet usually affects operation under load (high speed). Under normal circumstances, factory carburetor adjustments should not be disturbed. If the idle adjustment has been disturbed, turn the needle (counterclockwise) off its seat 1 to 1 1/2 turns to permit starting the engine, then readjust as follows:

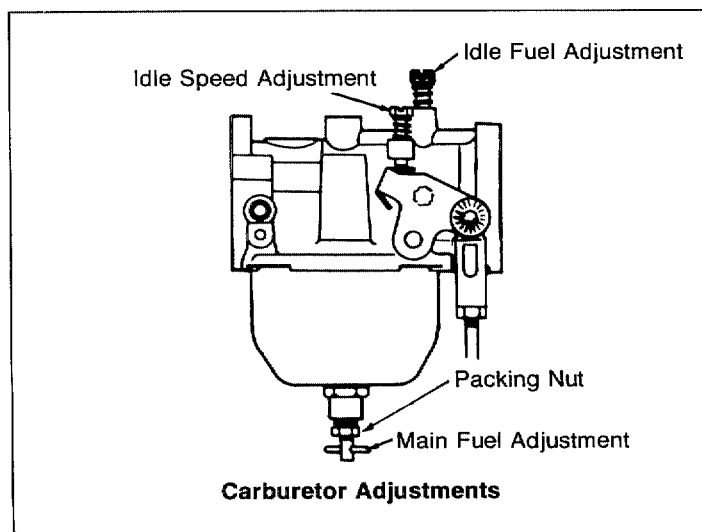
Carburetor Idle Adjustment

1. Allow the engine to run at least 10 minutes to warm it up.
2. Turn the idle needle out (counterclockwise) until engine begins to slow down or run unevenly. Remember this position.
3. Turn needle in (clockwise) past the position where the engine runs smoothly until it begins to slow down or run unevenly.

CAUTION: Do not force the needle against its seat; doing so will damage it.

4. Back the needle out to a position approximately halfway between the two positions. This should provide a smooth running idle.

CAUTION: Loosen the packing nut before making main fuel adjustment and then tighten the nut to a snug fit after the adjustment has been made. This procedure makes it easier to use the carburetor adjusting tool and prevents fuel leaks around the packing nut. Fuel leaks cause hard starting because the float level become lower than normal.



Carburetor Main (Load) Adjustment

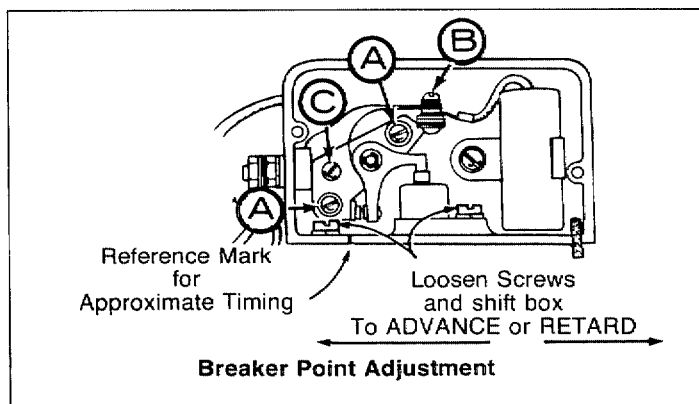
If engine runs unevenly at half or full load due to faulty carburetion, the main adjusting needle needs readjustment. For initial start-up, turn main adjustment 1 to 1 1/2 turns (counterclockwise) off its seat.

1. Start engine and allow it to warm up.
2. Set idle adjustment so engine runs smoothly.
3. Release governor mechanism to allow engine to accelerate. If engine accelerates evenly and without hesitation, main adjustment is correct. If not, turn needle outward about 1/2 turn and again slow the engine down and release the mechanism. Continue until the engine accelerates evenly and without hesitation after relasing the governor.
4. If engine tends to hunt (alternate increase and decrease of speed), open the main adjusting needle a little more. Do not open more than 1/2 turn beyond the maximum power point.

BREAKER POINTS

To maintain maximum efficiency from the engine, check condition of the beaker points every 200 hours of operation. Proceed as follows:

1. Remove the two screws and the cover on the breaker box.
2. Remove both spark plugs so engine can be easily rotated by hand. If plugs have not bee changed within the last 100 hours, clean and regap or replace them with new ones after setting the breaker points.
3. Remove the two mounting screws (A) and pull the points out of the box just far enough so screw (B) can be removed. Replace points with a new set (if needed) but do not completely tighten mounting screws (A).
4. Rotate the engine clockwise (facing flywheel) by hand until TC mark on gear cover aligns with TC mark on flywheel. Turn screw (C) until point gap measures .020" (0.508 mm) with a flat thickness gauge.
5. Tighten mounting screws and recheck gap.



ENGINE SAFETY PRECAUTIONS

It is recommended that you read your engine manual and become thoroughly acquainted with your equipment before you start the engine.

WARNING: This symbol is used through this manual to warn of possible serious personal injury.

CAUTION: This symbol refers to possible equipment damage.

Fuels, electrical equipment, batteries, exhaust gases and moving parts present potential hazards that could result in serious, personal injury. Take care in following these recommended procedures.

Safety Codes

- All local, state and federal codes should be consulted and complied with.

General

- Provide appropriate fire extinguishers and install them in convenient locations. Use an extinguisher rated ABC by NFPA.
- Make sure that all fasteners on the engine are secure. Tighten supports and clamps, keep guards in position over fans, driving belts, etc.
- If it is necessary to make adjustments while the engine is running, use extreme caution when close to hot exhausts, moving parts, etc.

Protect Against Moving Parts

- Do not wear loose clothing in the vicinity of moving parts, such as PTO shafts, flywheels, blowers, couplings, fans, belts, etc.
- Keep your hands away from moving parts.

Batteries

- Before starting work on the engine, disconnect batteries to prevent inadvertent starting of the engine.
- DO NOT SMOKE while servicing batteries. Lead acid batteries give off a highly explosive hydrogen gas which can be ignited by flame, electrical arcing or by smoking.
- Verify battery polarity before connecting battery cables. Connect negative cable last.

Fuel System

- DO NOT fill fuel tanks while engine is running, unless tanks are outside engine compartment.
- DO NOT smoke or use an open flame in the vicinity of the engine or fuel tank. Internal combustion engine fuels are highly flammable.
- Fuel lines must be of steel piping, adequately secured, and free from leaks. Piping at the engine should be approved flexible line. Do not use copper piping on flexible lines as copper will work harden and become brittle enough to break.
- Be sure all fuel supplies have a positive shutoff valve.

Exhaust System

- Exhaust products of any internal combustion engine are toxic and can cause injury, or death if inhaled. All engine installations, especially those within a confine, should be equipped with an exhaust system to discharge gases to the atmosphere.
- Do not use exhaust gases to heat a compartment.
- Make sure that your exhaust system is free of leaks. Ensure that exhaust manifolds are secure and are not warped by bolts unevenly torqued.

Cooling System

- Coolants under pressure have a higher boiling point than water. DO NOT open a radiator pressure cap while the engine is running. Bleed the system pressure first.

Keep the Unit and Surrounding Area Clean

- Make sure that oily rags are not left on or near the engine.
- Remove all oil deposits. Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and subsequent engine damage and may present a potential fire hazard.

PERIODIC SERVICE GUIDE

Regularly scheduled maintenance is the key to lower operating costs and longer service life for the unit. The following schedule can be used as a guide. However, actual operating conditions under which a unit is run should be the determining factor in establishing a maintenance schedule. When operating in very dusty or dirty conditions, some of the service periods may have to be reduced. Check the condition of the crankcase oil, the filters, cooling fins, etc. frequently until the proper service time periods can be established.

For any abnormalities in operation, unusual noises from engine or accessories, loss of power, overheating, etc., contact your nearest Onan Service Center.

PERIODIC MAINTENANCE SCHEDULE

Service These Items	After Each Cycle of Indicated Hours					
	8	50	100	200	400	1000
Inspect Engine Generally	X ₃					
Check Oil Level	X					
Service Air Cleaner		X ₁				
Change Crankcase Oil		X ₁				
Check Battery Electrolyte Level		X				
Clean Cooling Fins		X				
Clean and Regap Spark Plugs (Replace at 250 hours)			X			
Replace Oil Filter			X ₁			
Clean Breather Valve				X		
Check Breaker Points				X		
Replace Air Cleaner Element				X ₁		
Check Valve Clearance					X ₂	
Remove Carbon and Lead Deposits					X ₂	
Inspect Valves, Grind If Necessary						X ₂
Complete Reconditioning (If Required)						X ₂

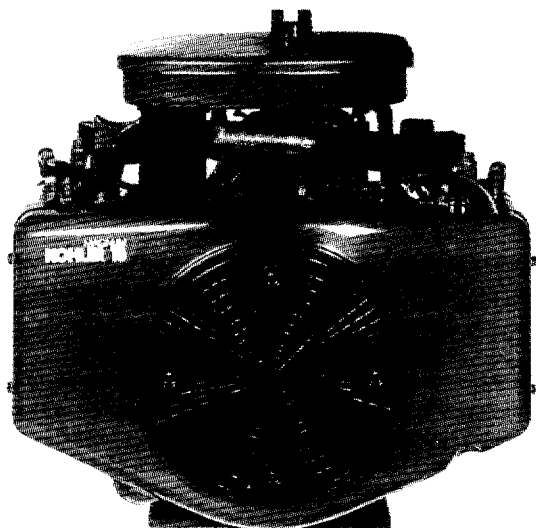
x₁ - Perform more often in extremely dusty conditions.

x₂ - For detailed maintenance, contact an Onan Service Center.

x₃ - Check for fuel leaks, exhaust leaks, etc.

KOHLER ENGINE SERVICE GUIDE

Magnum Model M20 HydraCat M-Series



SPECIFICATIONS

General

Horsepower (@ 3,600 rpm): 20

Displacement (cu. in.): 46.98

Bore: 3.12

Stroke: 3.06

Compression Ratio: 6.6:1

Approx. Weight (lb.): 130

Approx. Oil Capacity* (U.S. Quarts): 1.5

* For best results, fill to "F" mark on dipstick as opposed to adding a given quantity of oil. Always check level on dipstick before adding more oil. On engines equipped with oil filter, an additional 1/2 U.S. pint of oil is required when oil filter is replaced.

Valves and Tappets

Intake Valve to Tappet Clearance - Cold: .003/.006

Exhaust Valve to Tappet Clearance - Cold: .016/.019

Intake Valve Minimum Lift - Zero Lash: .274

Exhaust Valve Minimum Lift - Zero Lash: .274

Intake Valve Minimum Stem O.D.: .3103

Exhaust Valve Minimum Stem O.D.: .3088

Nominal Valve Seat Angle: 45°

Valve Guide Reamer Size: .3125

Intake Valve Guide I.D. Max. Wear Limit: .007

Fuel Recommendations

WARNING: Explosive Fuels! Gasoline is extremely flammable, and its vapors can explode if ignited. Store gasoline only in approved containers, in well-ventilated, unoccupied buildings, away from sparks or flames. Do not fill fuel tank while the engine is hot or running since spilled fuel could ignite if it comes in contact with hot parts or sparks from ignition. Do not start engine near spilled fuel; wipe up spills immediately. Never use gasoline as a cleaning agent.

For best results, use only clean, fresh, regular-grade, unleaded gasoline with a pump sticker octane rating of 87 or higher. In countries using the Research method, it should be 90 octane minimum.

Unleaded is recommended since it leaves less combustion chamber deposits. Regular-grade, leaded gasoline may also be used; however, be aware that the combustion chamber and cylinder head will require more frequent service. Refer to the "Periodic Maintenance" section.

Always use fresh gasoline. Fresh gasoline is blended for the season and reduces gum deposits which could clog the fuel system. Do not use gasoline left over from the previous season.

Do not add oil to the gasoline.

Keep the vent hole in fuel tank cap open. If vent hole is plugged, pressure may build up in tank, causing carburetor flooding or dangerous spraying of gasoline when tank cap is removed. A vacuum may also be created during operation which could stop fuel flow to the carburetor.

PERIODIC MAINTENANCE KOHLER ENGINE

Required Maintenance:

These required maintenance procedures should be performed at the frequency stated in the table:

Required Maintenance	Frequency
Check Oil Level	Daily
Clean Grass Screen	Daily*
Check/Replace Fuel Filter	As Required
Change Oil and Filter	As Specified in "Oil Change Intervals" Table
Clean Foam Precleaner	25 Hours*
Clean Cooling Fins and External Surfaces	50 Hours*
Clean Paper Air Cleaner Element	100 Hours*
Check Spark Plugs	100 Hours
Check Valve-To-Tappet Clearance	500 Hours
Clean Cylinder Heads and Combustion Chambers	500 Hours**
Service Starter Motor Drive	Annually or 500 Hours

*Perform these maintenance procedures more frequently when engine is operated under extremely dusty and dirty conditions.

**250 Hours when leaded gasoline is used.

WARNING: Accidental Starts! Before servicing the engine or equipment, always remove the spark plug leads to prevent the engine from starting accidentally. Ground the leads to prevent sparks that could cause fires.

OIL

Oil Filter

Some engines are equipped with an oil filter. Replace the oil filter every other oil change, in accordance with the "Oil Change Intervals" table. Always use a genuine Kohler replacement oil filter.

Check Oil Level

The importance of checking and maintaining the proper oil level in crankcase cannot be overemphasized. Check oil BEFORE EACH USE as follows:

1. Make sure the engine is stopped, level, and is cool so the oil has had time to drain into the sump.
2. Clean the area around dipstick before removing to keep dirt, grass clippings, etc., out of the engine.
3. Remove dipstick and wipe oil off. Reinsert dipstick and push it all the way down into tube. Remove dipstick and check the level.

The oil level should be up to, but not over, the "F" mark on the dipstick. Refer to Figure 1.

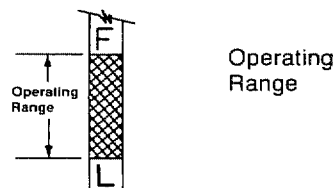


Figure 1. Oil Level Range

4. Add the proper type of oil if the level is low. Always check the level with dipstick before adding more oil.

CAUTION: Never operate the engine with the oil level below "L" mark or over "F" mark on dipstick.



Oil Sentry™

Some engines are equipped with optional Oil Sentry oil pressure monitor. Oil Sentry will either stop the engine or activate a "low oil" warning light, if the oil pressure gets low. Actual Oil Sentry use will vary depending on the engine application.

CAUTION: Oil Sentry is not a substitute for checking oil level BEFORE EACH USE. Make sure the oil level is maintained up to the "F" mark on dipstick.

Change Oil

For new engine, change oil after the first 5 hours of operation. Thereafter, change oil as specified in the "Oil Change Intervals" table.

For an overhauled engine or those rebuilt with a new short-block, use straight 30-weight Service Class SF oil for the first 5 hours of operation. Change the oil after this initial run-in period. Thereafter, change the oil as specified in the "Oil Change Intervals" table.

Drain oil while the engine is still warm from operation. The oil will flow more freely and carry away more impurities. Change oil as follows:

1. Remove the oil drain plug and dipstick. Refer to Figure 2. Tilt the engine slightly towards the drain hole to obtain better drainage.
2. Reinstall the drain plug. Make sure it is tightened securely.
3. Fill with new oil of the proper type to the "F" mark on the dipstick. Always check the level on dipstick before adding more oil. Make sure the engine is level when filling and checking oil.

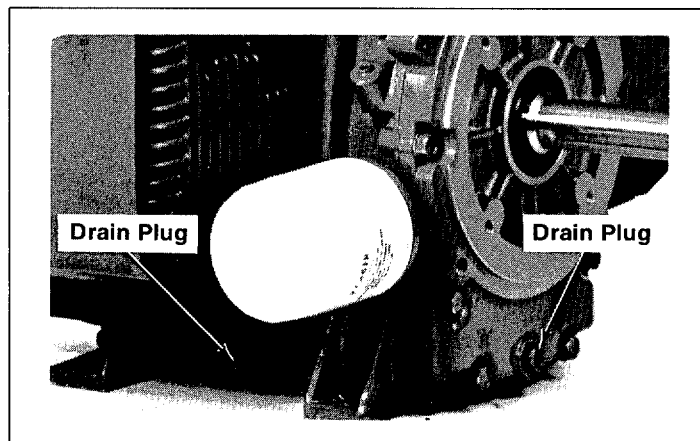


Figure 2. Oil Filter, Oil Drain Plug Location

OIL CHANGE INTERVALS

Temperature	Oil Type	Engine Type	Interval
ABOVE 32°F (0°C)	SAE 30	With Filter	50 Hours*
		Without Filter	25 Hours
	Multiviscosity	With Filter	25 Hours
		Without Filter	25 Hours
BELOW 32°F (0°C)	Multiviscosity	With Filter	50 Hours
		Without Filter	25 Hours

*25 hours for continuous and/or heavy duty operation.

Change Oil Filter

Change the oil filter every other oil change, in accordance with the "Oil Change Intervals" table. Always use a genuine Kohler oil filter and change as follows:

1. Drain crankcase oil, then remove old filter.
2. Before installing replacement filter, apply a thin coating of oil on surface of the rubber seal.
3. Turn filter clockwise until rubber seal contacts the filter adapter, then tighten the filter an additional turn.
4. Add an additional 1/2 pint of oil for the filter capacity.
5. Start the engine and check for and correct any oil leaks.

AIR SYSTEM

Service Air Cleaner

Magnum engines are equipped with a high-density paper air cleaner element. Some specifications are also equipped with an oiled foam precleaner which surrounds the paper element. Refer to Figure 3.

Also refer to the "Air Cleaner" section for disassembly and reassembly procedures for all styles of air cleaners used on these engines.

Precleaner

If so equipped, wash and reoil the precleaner every 25 operating hours (more often under extremely dusty, dirty conditions).

1. Remove precleaner from paper element. Wash the precleaner in warm water with detergent.
2. Rinse precleaner thoroughly until all traces of detergent are eliminated. Squeeze out excess water (do not wring). Allow precleaner to air dry.

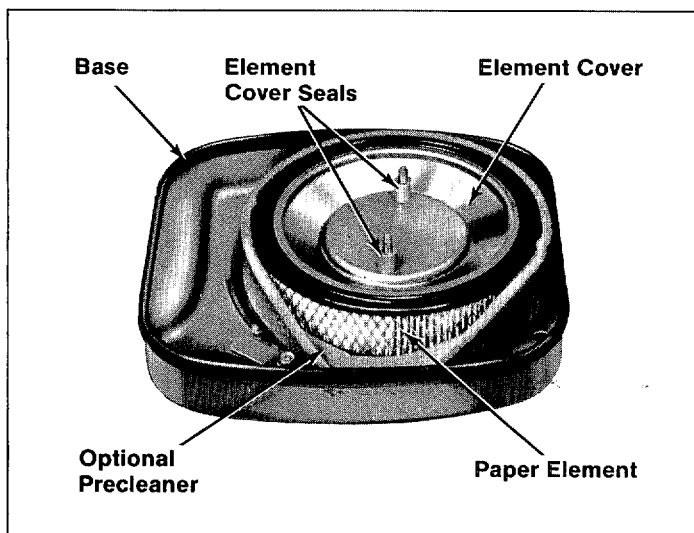


Figure 3. Air Cleaner Components

3. Saturate precleaner in clean, fresh engine oil. Squeeze out excess oil.
4. Reinstall precleaner over paper element.

Paper Element

Every 100 operating hours (more often under extremely dusty, dirty conditions), check the paper element. Clean or replace element as follows:

1. Remove the precleaner (if so equipped), element cover seals, element cover, and paper element.
2. Gently tap the flat side of element to dislodge dirt. Replace a dirty, bent, or damaged element with a new genuine Kohler

element. Handle new elements carefully; do not use if surfaces are bent or damaged.

CAUTION: Do not wash the paper element or use compressed air as this will damage element.

3. Reinstall the paper element, element cover, and element cover seals.
4. Install the precleaner (cleaned and oiled) over paper element.
5. Install air cleaner cover and wing nuts. Tighten wing nuts 1/2 to 1 full turn after nuts contact cover—do not overtighten.

Inspect Air Cleaner Components

Whenever the air cleaner cover is removed, or the element or precleaner serviced, check the following components:

- Air Cleaner Base - Make sure it seals tightly against intake elbow, and is not bent or damaged.
- Element Cover and Element Cover Seals - Make sure element cover is not bent or damaged. Make sure element cover seals are in place to ensure element is sealed tightly between element cover and air cleaner base.
- Breather Tube - Make sure it is sealed tightly in air cleaner base and breather cover.

CAUTION: Damaged, worn, or loose air cleaner components could allow unfiltered air into the engine causing premature wear and failure. Replace all damaged or worn components.

SPARK PLUGS

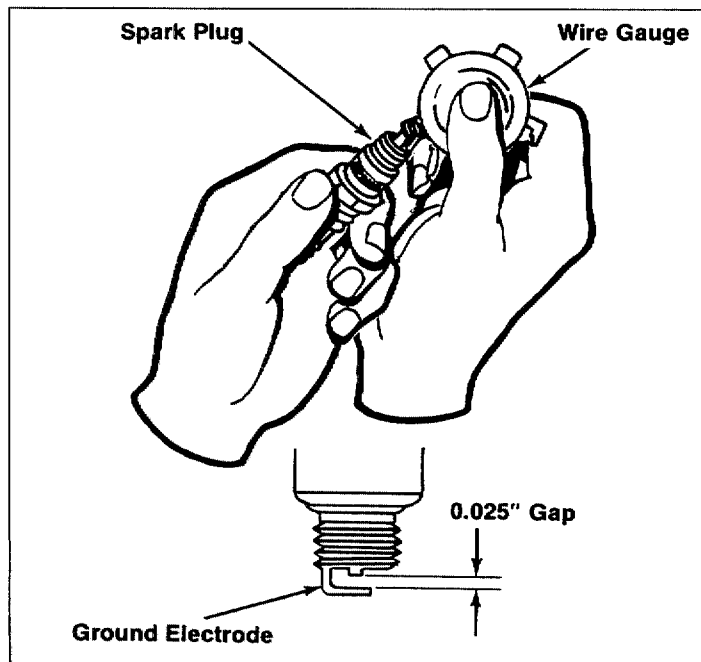


Figure 4. Servicing Spark Plugs

Check Spark Plugs

Every 100 operating hours, remove the spark plugs, check condition and reset gaps, or replace with new plugs as necessary. Refer to Figure 4.

1. Before removing spark plugs, clean the area around the base of plugs to keep dirt and debris out of engine.
2. Remove the plugs and check condition. Replace the plugs if worn or if reuse is questionable.

CAUTION: Do not clean the spark plugs in a machine using abrasive grit. Some grit could remain in spark plugs and enter the engine causing extensive wear and damage.

3. Check gaps using a wire feeler gauge. Adjust gaps to 0.025" by carefully bending the ground electrode.

4. Reinstall spark plugs into cylinder heads. Torque plugs to 10/15 ft. lb.

IGNITION

IGNITION SYSTEM SERVICE

Magnum engines are equipped with a dependable electronic magneto ignition system. Other than periodically checking/replacing the spark plugs, no maintenance, timing, or adjustments are necessary or possible with this system.

SERVICE STARTER MOTOR DRIVE

Every 500 operating hours, or annually (whichever occurs first), clean and lubricate the drive splines of the Bendix-drive electric starter motor. Refer to Figure 5.

1. Remove starter from crankcase. (Refer to the "Disassembly" section.)
2. Remove dust cover, stop nut, stop gear spacer, spring, dust cover spacer, and drive pinion.
3. Clean the drive shaft splines with solvent. Dry splines thoroughly.
4. Apply a small amount of Kohler electric starter drive lubricant (Part No. 52 357 01) to splines.

CAUTION: Kohler starter drive lubricant (Part No. 52 357 01) must be used on all Kohler electric starter drives. The use of other lubricants can cause the drive to stick or bind.

5. Apply a small amount of Loctite® No. 271 to stop nut threads. Assemble drive parts in reverse order of removal. Torque stop nut to 160 in. lb.
6. Reinstall starter to crankcase.

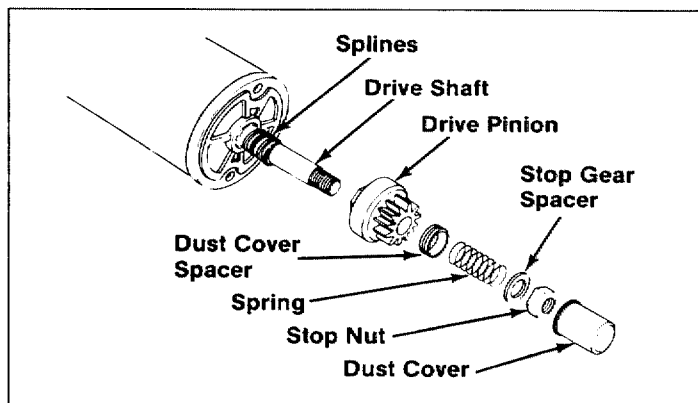


Figure 5. Starter Drive Components

FUEL

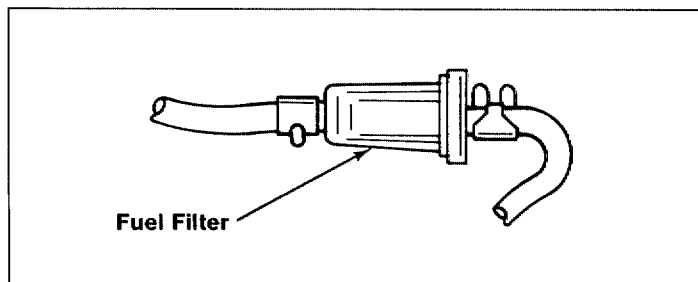


Figure 6. In-line Fuel Filter

Check Fuel Filter

Some engines are equipped with an in-line fuel filter. Visually inspect the filter periodically. Replace when dirty with a genuine Kohler filter.

CYLINDER HEADS

CLEAN CYLINDER HEADS AND COMBUSTION CHAMBERS

Every 500 operating hours (250 hours when leaded gasoline is used), remove cylinder heads and clean combustion chambers. Refer to Figure 7.

1. Remove cylinder head baffles and cylinder heads.
2. Clean away combustion deposits using a wooden or plastic scraper.
3. Reinstall cylinder heads using new gaskets. Torque cylinder head fasteners to 15/20 ft. lb. in the sequence specified in Figure 7.

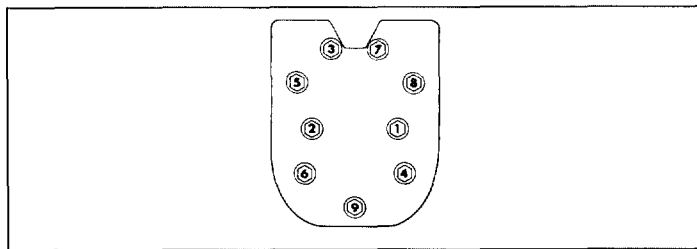
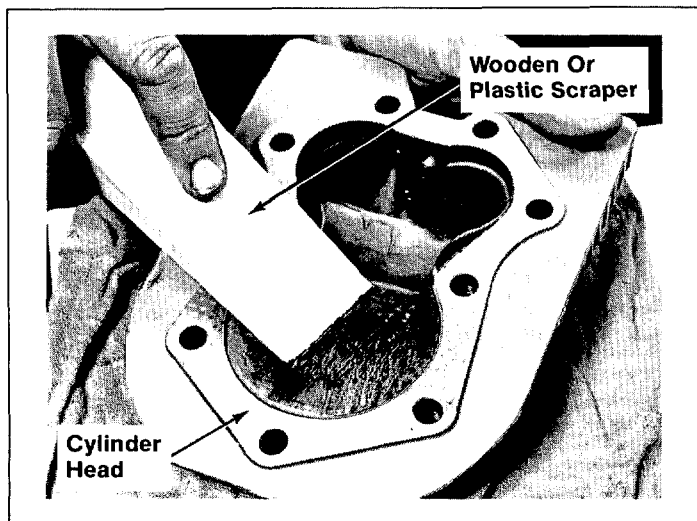


Figure 7. Cleaning Cylinder Heads / Combustion Chambers And Tightening Sequence

VALVE CLEARANCE

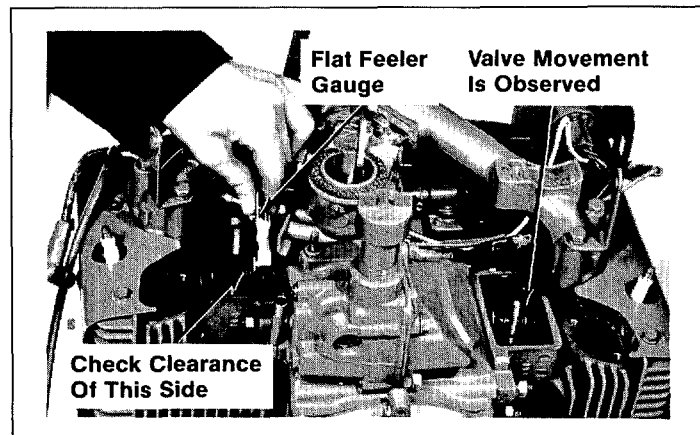


Figure 8. Measuring Valve-To-Tappet Clearance

CHECK VALVE-TO-TAPPET CLEARANCE

Every 500 operating hours, remove breather/valve covers and check valve-to-tappet clearance with a flat feeler gauge. Refer to Figure 8. The engine must be cold when checking this clearance.

REMOVE AIR CLEANER, VALVE COVERS, BREATHER, AND SPARK PLUGS

1. Disassemble air cleaner. Disconnect breather tube from air cleaner base. Remove base from air intake elbow and intake manifold.
2. Remove the valve cover and breather assembly from the #1 cylinder barrel. Remove the valve cover from the #2 cylinder barrel.
3. Remove the spark plugs.

MEASURE VALVE-TO-TAPPET CLEARANCE

IMPORTANT: The piston must be at top dead center (TDC) of the compression stroke to measure valve-to-tappet clearance. By rotating the flywheel and observing the valves and tappets for movement, it can be determined if a cylinder is at TDC.

If, for example, the flywheel is rotated and movement is noticed in the #2 side valve box—the opposite cylinder (#1 side) will be at TDC and valve-to-tappet clearance can be measured.

Rotating the flywheel one complete revolution (360°) will then cause movement in the #1 side valve box—the #2 side cylinder will be at TDC, enabling measurement of valve-to-tappet clearance for that side.

Intake Valve (Closest to Flywheel): .003"/.006"

Exhaust Valve (Closest to PTO): .016"/.019"

1. Rotate the flywheel and look into the valve boxes. The valves and tappets will move in only one of the boxes. Measure the valve-to-tappet clearance for the cylinder in which no movement was observed—use a flat feeler gauge. Refer to Figure 8.
2. Rotate the flywheel 360° and measure the valve-to-tappet clearance for the remaining cylinder.
3. If clearance is too small, remove the valves and grind the valve stems until the correct clearance is obtained. Make sure valve stems are ground perfectly flat and smooth.

If clearance is too large, replace the valves and recheck clearance.

NOTE: Large clearances can also be reduced by grinding the valves and/or valve seats.

REINSTALL SPARK PLUGS, BREATHER, VALVE COVERS, AND AIR CLEANER

1. Reinstall spark plugs and torque to 10/15 ft. lb.
2. Reinstall valve cover to #2 cylinder barrel. Reinstall breather assembly and valve cover to #1 cylinder barrel. Make sure breather is assembled correctly using new gaskets.
3. Reinstall air cleaner base to intake manifold and air intake elbow using new gasket.
4. Insert end of breather tube through hole in air cleaner base.
CAUTION: Make sure breather tube seals tightly in breather cover and in air cleaner base to prevent unfiltered air from entering engine.
5. Reassemble remaining air cleaner components and tighten wing nut(s) 1/2 to 1 full turn after nut contacts cover. Do not overtighten.
6. Reconnect spark plug leads.

STORAGE

If the engine will be out of service for approximately two months or more, use the following storage procedure:

1. Change the oil and filter when engine is still warm from operation. Refer to "Change Oil." Run the engine for a few minutes to distribute the clean oil.
2. Drain the fuel tank and fuel system (or run engine until fuel tank and fuel system are empty).

(continued next page)

3. Remove the spark plugs. Add one tablespoon of engine oil into each spark plug hole. Install plugs, but do not connect plug leads. Crank the engine two or three revolutions.
4. Clean the exterior surfaces of engine. Spread a light film of oil over any exposed metal surfaces of engine to prevent rust.
5. Store the engine in a clean, dry place.

KOHLER ENGINE TROUBLE SHOOTING GUIDE

When troubles occur, be sure to check the simple causes which, at first, may seem too obvious to be considered. For example, a starting problem could be caused by an empty fuel tank.

Some common causes of engine troubles are listed below—use this as a guide to locate causing factors.

PROBLEM: Engine Cranks But Will Not Start

Solution

Empty fuel tank.
Clogged fuel line.
Spark plug leads disconnected.
Keyswitch or kill switch in "off" position.
Faulty spark plugs.
Faulty ignition module.
Dirt or water in fuel system.

PROBLEM: Engine Starts But Does Not Keep Running

Solution

Restricted fuel tank vent.
Dirt or water in fuel system.
Faulty choke or throttle controls/cables.
Loose wires or connections which short kill terminal of ignition module to ground.
Carburetor improperly adjusted.
Faulty cylinder head gaskets.
Faulty fuel pump.

PROBLEM: Engine Starts Hard

Solution

Loose wires or connections.
Dirt or water in fuel system.
Clogged or restricted fuel lines.
Faulty choke or throttle controls/cables.
Faulty spark plugs.
Carburetor improperly adjusted.
Incorrect valve-to-tappet clearance.
Low compression.

PROBLEM: Engine Will Not Crank

Solution

Battery is discharged.
Loose or faulty wires or connections.
Faulty keyswitch or ignition switch.
Faulty electric starter/starter solenoid.
Seized internal engine components.

PROBLEM: Engine Runs But Misses

Solution

Dirt or water in fuel system.
Spark plug leads loose.
Loose wires or connections which intermittently short kill terminal of ignition module to ground.
Carburetor improperly adjusted.
Engine overheating.
Incorrect valve-to-tappet clearance.
Faulty ignition module.

PROBLEM: Engine Will Not Idle

Solution

Idle speed adjusting screw improperly set.
Dirt or water in fuel system.
Idle fuel adjusting screw improperly set.
Restricted fuel tank vent.
Faulty spark plugs.
Incorrect valve-to-tappet clearance.
Low compression.

PROBLEM: Engine Overheats

Solution

Grass screen, cooling fins, or shrouding clogged.
Excessive engine load.
Low crankcase oil level.
High crankcase oil level.
Carburetor improperly adjusted.

PROBLEM: Engine Knocks

Solution

Low crankcase oil level.
Excessive engine load.

PROBLEM: Engine Loses Power

Solution

Low crankcase oil level.
High crankcase oil level.
Restricted air cleaner element.
Dirt or water in fuel system.
Excessive engine load.
Engine overheating.
Faulty spark plugs.
Carburetor improperly adjusted.
Low compression.

PROBLEM: Engine Uses Excessive Amount of Oil

Solution

Incorrect oil viscosity or type.
Clogged or improperly assembled breather system.
Worn or broken piston rings.
Worn cylinder bores.
Worn valve stems and/or valve guides.

CARBURETOR

This subsection covers the adjustment, disassembly, cleaning, inspection, repair, and reassembly of Kohler-built, side draft, adjustable jet carburetors.

WARNING: Explosive Fuel! Gasoline may be present in the carburetor and fuel system. Gasoline is extremely flammable and its vapors can explode if ignited. Keep sparks, open flame and other sources of ignition away from engine. Wipe up spilled fuel immediately.

ADJUSTMENT

The carburetor is designed to deliver the correct fuel/air mixture to the engine under all operating conditions. Carburetors are set at the factory and normally do not need adjustment. If the engine exhibits conditions like those found in the table below, it may be necessary to adjust the carburetor.

Turning the adjusting needles in (clockwise) decreases the supply of fuel to the carburetor. This gives a leaner fuel/air mixture. Turning the adjusting needles out (counterclockwise) increases the supply of fuel to the carburetor. This gives a richer fuel/air mixture. Refer to Figures 9 and 10.

CAUTION: Incorrect settings can cause a fouled spark plug, overheating, excessive valve wear, and other problems. To ensure correct settings, make sure the following adjustment procedures are used.

Make carburetor adjustments after the engine has warmed.

1. Stop the engine. Turn the main fuel and idle fuel adjusting needles in (clockwise) until they bottom lightly.

CAUTION: The ends of the main fuel and idle fuel adjusting needles are tapered to critical dimensions. Damage to needles and seats will result if the needles are forced.

2. **Preliminary Settings:** Turn the main fuel and idle fuel adjusting needles out (counterclockwise) from lightly bottomed as follows:

Main Fuel Needle 2½ Turns

Idle Fuel Needle 1 Turn

3. Start the engine and run at half-throttle for 5-10 minutes to warm up. Engine must be warm before making final settings (steps 4-5).

4. **Final Setting - Main Fuel:** Place throttle in wide open position; and if possible, place engine under load. Turn main fuel adjusting needle out (counterclockwise) from preliminary setting until the engine speed decreases (rich). Note the position of the needle.

Now turn the adjusting needle in (clockwise). The engine speed may increase, then it will decrease as the needle is turned in (lean). Note the position of the needle.

Set the adjusting needle midway between the rich and lean settings noted.

5. **Final Setting - Idle Fuel:** Place throttle into idle or slow position. Set idle fuel adjusting needle using the same procedure as in step 4.

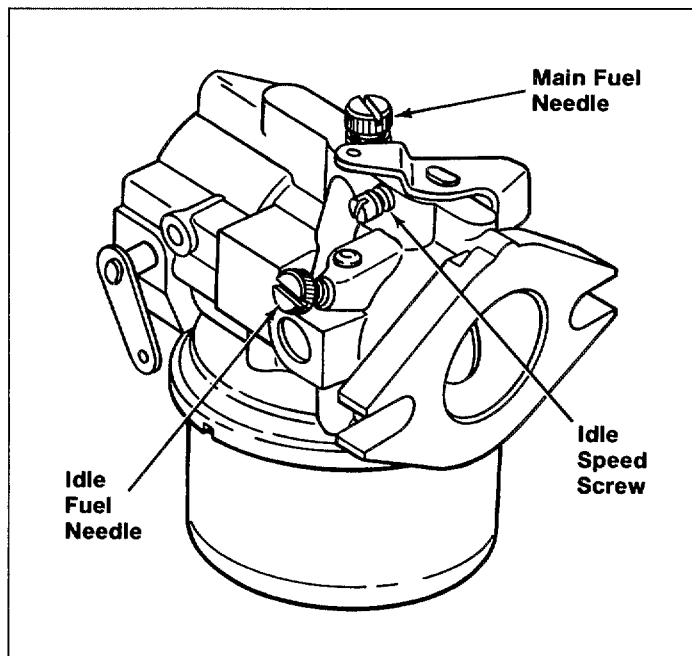


Figure 9. Kohler-Built Adjustable Jet Carburetor

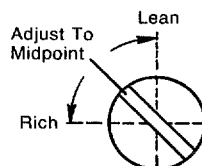


Figure 10. Carburetor Adjustment

CLEANING

WARNING: Flammable Solvents! Carburetor cleaners and solvents are extremely flammable. Keep sparks, flames, and other sources of ignition away from area. Follow the cleaner manufacturer's warnings and instructions on its proper and safe use. Never use gasoline as a cleaning agent.

To Replace Throttle and Choke Shafts

WARNING: Prevent Eye Injury! Suitable eye protection (safety glasses, goggles, or face hood) should be worn for any procedure involving the use of compressed air, punches, hammers, chisels, drills, or grinding tools.

Disassembly

1. Remove the bowl retaining screw, retaining screw gasket, and fuel bowl.
2. Remove the float pin, float, fuel inlet needle, baffle gasket, and bowl gasket.
3. Remove the fuel inlet seat and inlet seat gasket. Remove the idle fuel and main fuel adjusting needles and springs. Remove the idle speed adjusting screw and spring.
4. Further disassembly to remove the throttle and choke shafts is recommended only if these parts are to be replaced. (Figure 12)

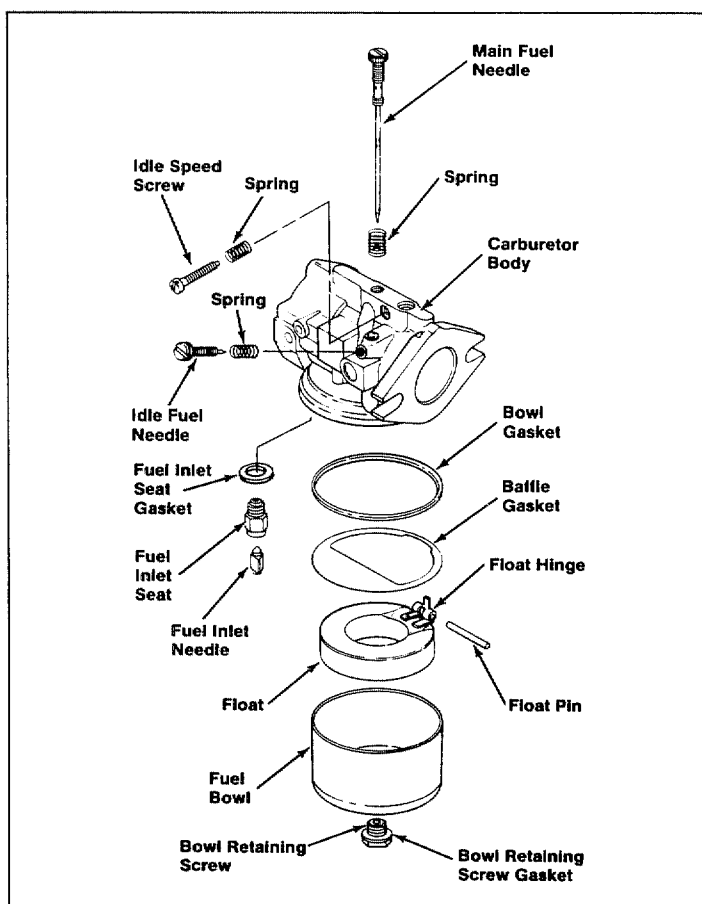


Figure 11. Kohler-Built Adjustable Jet Carburetor

Remove Choke Plate and Choke Shaft; Transfer Choke Lever

1. To ensure correct reassembly, mark choke plate and carburetor body with a marking pen. Also take note of choke plate position in bore, and choke lever position.
2. Carefully and slowly remove the screws securing choke plate to choke shaft. Remove and save the choke plate as it will be reused.
3. File off any burrs which may have been left on choke shaft when screws were removed. Place carburetor on work bench with choke side down. Remove choke shaft; the detent ball and spring will drop out.
4. Note the position of the choke lever with respect to the cutout portion of choke shaft.
5. Carefully grind or file away the riveted portion of shaft. Remove and save choke lever; discard old choke shaft.
6. Install choke lever to new choke shaft from kit. Make sure lever is installed correctly as noted in step 5. Apply Loctite to threads of (1) #3-48x7/32" brass screw; secure lever to shaft.

Remove Throttle Plate And Throttle Shaft; Transfer Throttle Lever

1. To ensure correct reassembly, mark throttle plate and carburetor body with a marking pen. Also take note of throttle plate position in bore, and throttle lever position.
2. Carefully and slowly remove the screws securing the throttle plate to throttle shaft. Remove and save the throttle plate as it will be reused.
3. File off any burrs which may have been left on throttle shaft when screws were removed.
4. Remove the throttle shaft from carburetor body. Remove and discard the foam rubber dust seal from throttle shaft.

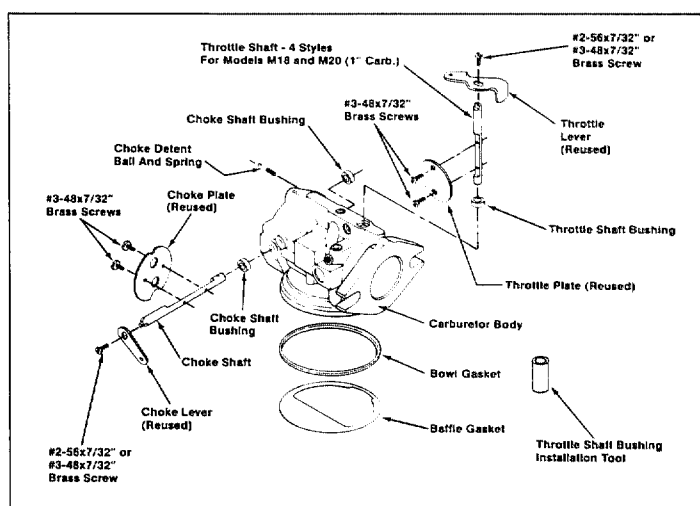


Figure 12. Throttle And Choke Shaft Replacement Kit

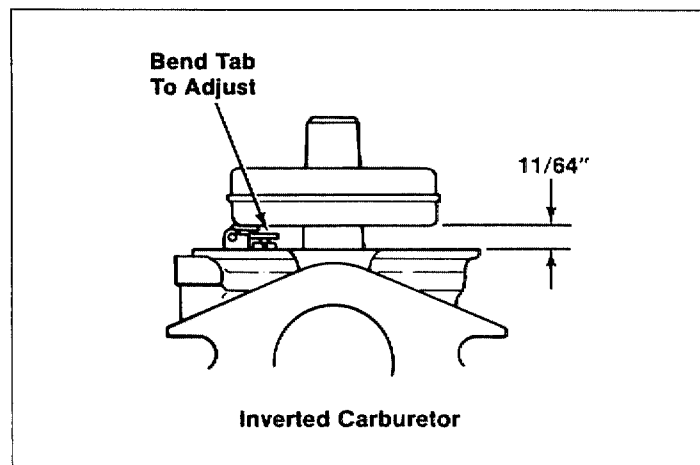


Figure 13. Setting Float Level

5. Remove/transfer throttle lever as follows:
 - a. Note the position of the throttle lever with respect to the cutout portion of throttle shaft.
 - b. Carefully grind or file away the riveted portion of shaft; remove throttle lever.
 - c. Carefully compare the old shaft to the new shafts from kit. Select the appropriate new shaft and discard the old shaft.
 - d. Install throttle lever to throttle shaft. Make sure lever is installed correctly as noted in step a.
 - e. Apply Loctite to threads of (1) #2-56x7/32" brass screw (use #3-48x7/32" screw with 2-49/64" shaft); secure lever to shaft.

Reassembly

1. Install the fuel inlet seat gasket and fuel inlet seat into carburetor body. Torque seat to 35/45 in. lb.
2. Install the fuel inlet needle into inlet seat. Install float and slide float pin through float hinge and float hinge towers on carburetor body.
3. Set float level: Invert carburetor so the float tab rests on the fuel inlet needle. There should be 11/64" ($\pm 1/32$ ") clearance between the machined surface of body and the free end of float. Bend the float tab with a small screwdriver to adjust. Refer to Figure 13.
4. Set float drop; Turn the carburetor over to its normal operating position and allow float to drop to its lowest level. The float drop should be limited to 1-1/32" between the machined sur-

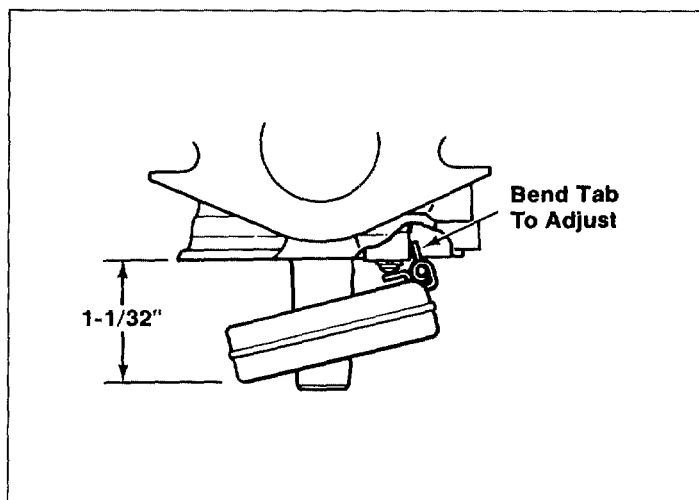


Figure 14. Setting Float Drop

face of body and the bottom of the free end of float. Bend the float tab with a small screwdriver to adjust. Refer to Figure 14.

5. Check float to float hinge tower clearance: Invert the carburetor so the float tab rests on the fuel inlet needle. Insert a .010" feeler gauge between float and float hinge towers. If the feeler gauge cannot be inserted, or there is interference between the float and towers, file the towers to obtain the proper clearance. Refer to Figure 15.
6. Install the bowl gasket and baffle gasket. Position baffle gasket so the inner edge is against the float hinge towers.
7. Install the fuel bowl so it is centered on the baffle gasket. Make sure the baffle gasket and bowl are positioned properly to ensure a good seal.

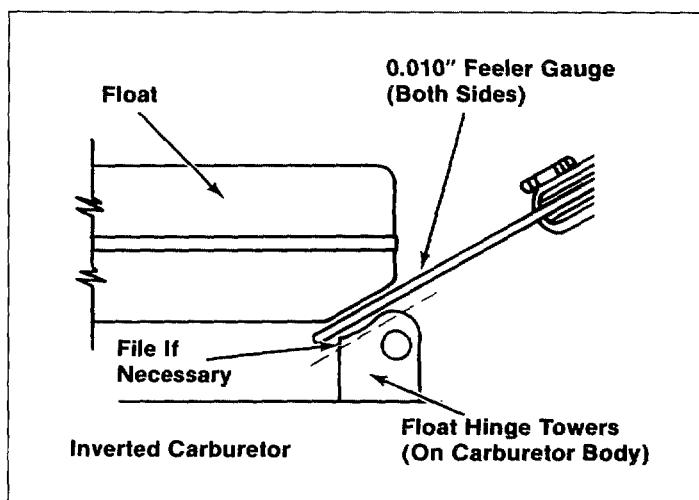


Figure 15. Checking Float Clearance

8. Install the bowl retaining screw gasket and bowl retaining screw. Torque screw to 50/60 in. lb.
 9. Install the idle speed adjusting screw and spring. Install the idle fuel and main fuel adjusting needles and springs. Turn the adjusting needles clockwise until they bottom lightly.
- CAUTION:** The ends of adjusting needles are tapered to critical dimensions. Damage to needles and seats will result if needles are forced.
10. Reinstall the carburetor to the engine using a new gasket.
 11. Adjust the carburetor as outlined under the "Adjustment" portion of this section.

CARBURETOR TROUBLE SHOOTING GUIDE

PROBLEM: Black Sooty Exhaust Smoke*, Engine Sluggish

Cause	Solution
Main fuel moisture too rich.	Turn main fuel adjusting needle in (clockwise).

PROBLEM: Engine Misses and Backfires at High Speed

Cause	Solution
Main fuel moisture too lean.	Turn main fuel adjusting needle out (counterclockwise).

PROBLEM: Engine Starts and Then Stops Under Cold Weather Conditions

Cause	Solution
Main fuel moisture too lean.	Turn main fuel adjusting needle out (counterclockwise).

PROBLEM: Engine Runs Roughly or Stalls at Idle Speed

Cause	Solution
Idle speed too low or improper idle fuel mixture.	Turn idle speed adjusting screw, then idle fuel adjusting needle.

* If black exhaust smoke is noted, check the air cleaner first. An apparent "overrich" mixture can actually be caused by a clogged air cleaner element. If after element is replaced, black smoke or other problems continue, adjust the carburetor immediately.

LUBRICATION SYSTEM

OPERATION

Magnum M18 and M20 engines use a full-pressure lubrication system that delivers oil to the crankshaft, camshaft, and connecting rod journal surfaces. Under normal engine operating conditions, the oil pressure can be as high as 50 psi. A high-efficiency gerotor oil pump maintains high oil flow and oil pressure, even at low speeds and high operating temperatures. A pressure relief valve, located in the engine crankcase behind the closure plate, limits the maximum oil pressure in the system. No adjustments to relief valve are possible. Refer to Figure 16.

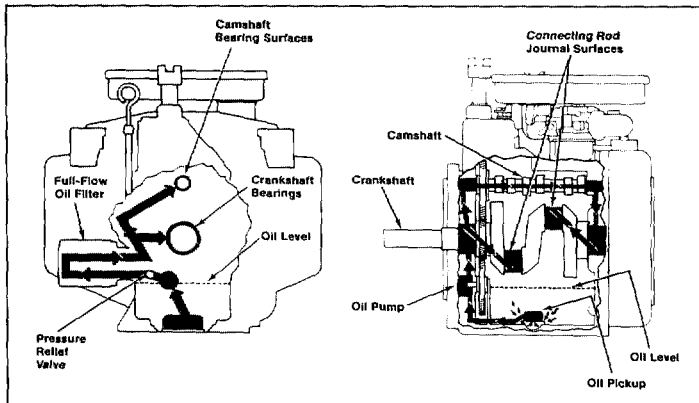


Figure 16. Full-Pressure Lubrication System

LUBRICATION SYSTEM SERVICE

The oil pump cover and rotors, and pressure-relief valve can be serviced without splitting the crankcase. Remove the rear closure plate to service those parts.

The crankcase must be split to service the pump shaft, drive gear, oil pickup, etc. Refer to Figures 17, 18, and 19.

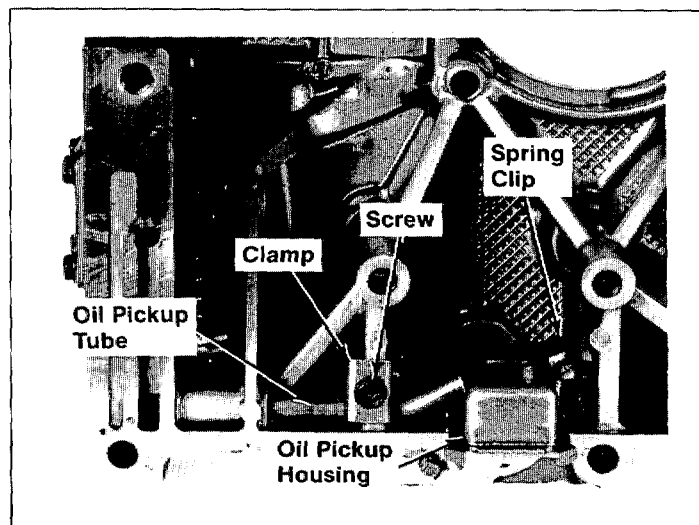


Figure 17. Oil Pickup

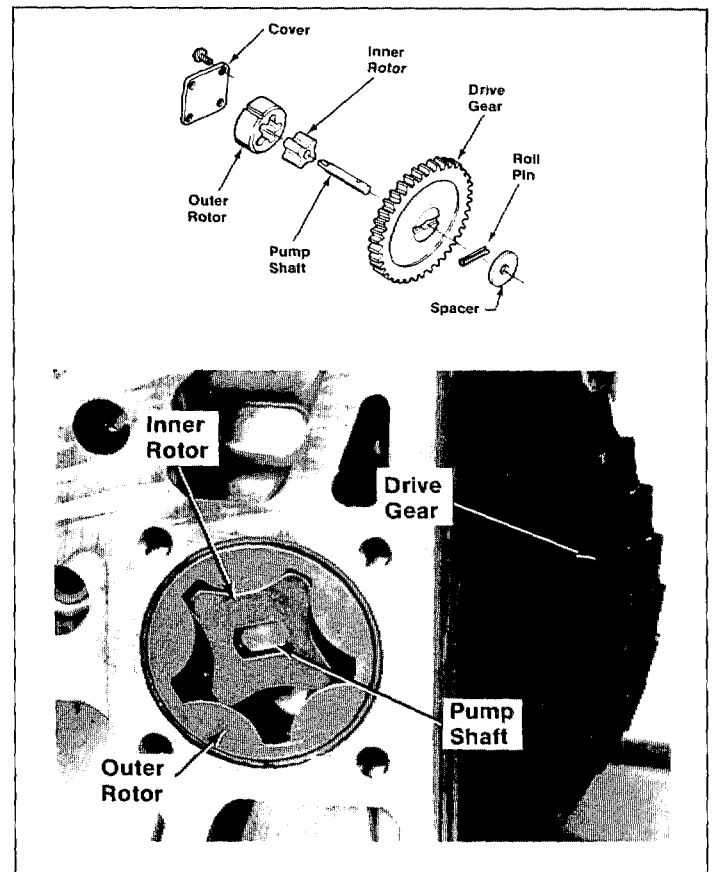


Figure 18. Oil Pump Assembly

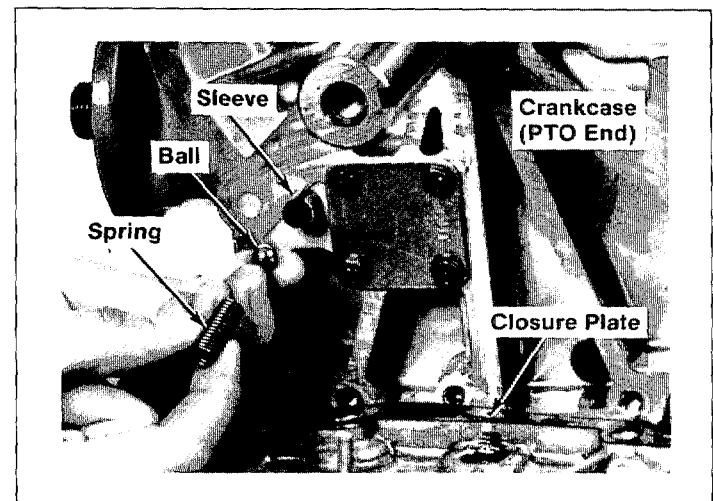


Figure 19. Oil Pressure Relief Valve

OIL FILTER

All basic engines are equipped with a full-flow oil filter. The filter helps remove sludge and other combustion by-products from the oil, extends the oil change interval, and helps cool the oil.

Oil filters are optional for special spec engines and are available in engine-mounted or remote-mounted types. A cover plate seals the crankcase on those engines not equipped with an oil filter.

Refer to Figures 20 & 21. Also refer to the "Periodic Maintenance" (page 29) section for oil and oil filter change instructions.

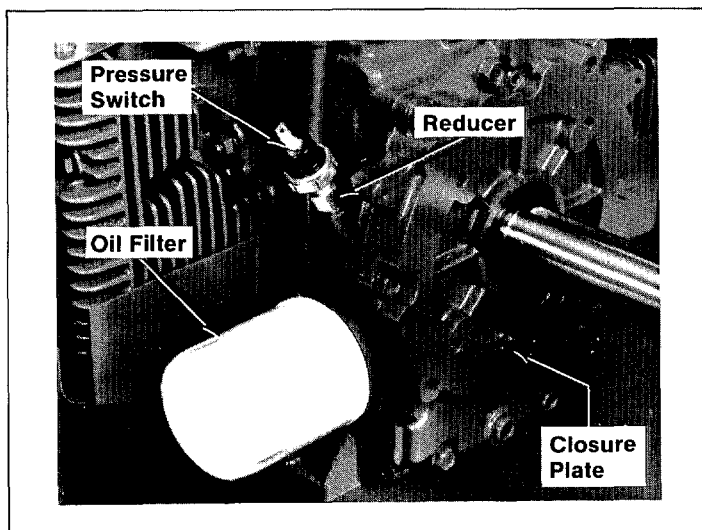


Figure 20. Engine Mounted Oil Filter And Oil Sentry Pressure Switch

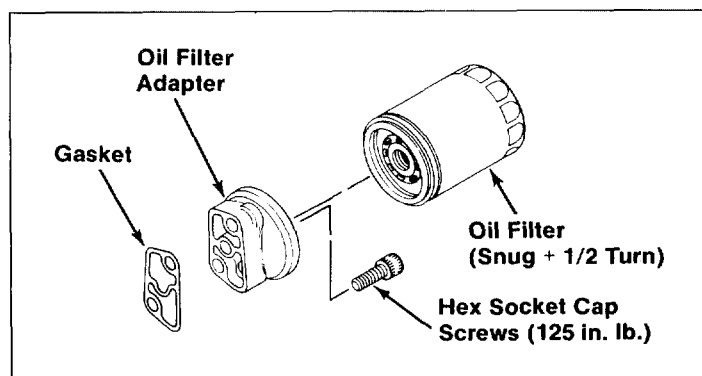


Figure 21. Installation Torques—Engine Mounted Oil Filter

ELECTRICAL SYSTEMS AND COMPONENTS

MAGNUM ELECTRONIC MAGNETO IGNITION SYSTEM

This engine is equipped with a state-of-the-art electronic magneto ignition system. The system consists of the following components (refer to Figure 22).

- A magnet assembly, which is PERMANENTLY affixed to the flywheel.
- An electronic magneto ignition module, which is mounted to the #1 side cylinder barrel.
- A kill switch (or keyswitch) which stops the engine by grounding the ignition module.

Operation

As the flywheel rotates and the magnet assembly moves past the ignition module, a low voltage is induced in the primary windings of the module. When the primary voltage is precisely at its peak, the module induces a high voltage in its secondary windings. This high voltage creates a spark at the tip of the spark plugs, igniting the fuel-air mixture in the combustion chambers. The timing of the spark is automatically controlled by the module. Therefore, no ignition timing adjustments are necessary or possible with this system.

CAUTION: Do not connect 12 volts to the ignition system or to any wire connected to the ignition module.

The ignition system operates independently of the battery, starting, charging, and other auxiliary electrical systems. Connecting 12

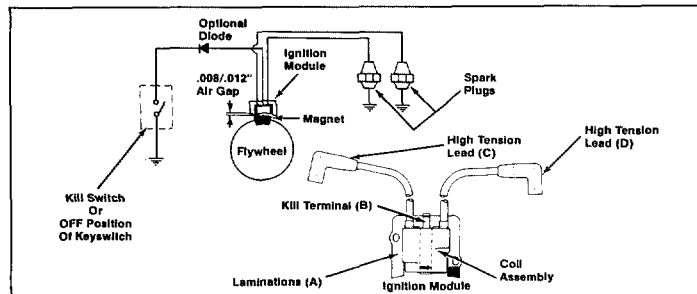


Figure 22. Magnum Electronic Magneto Ignition System

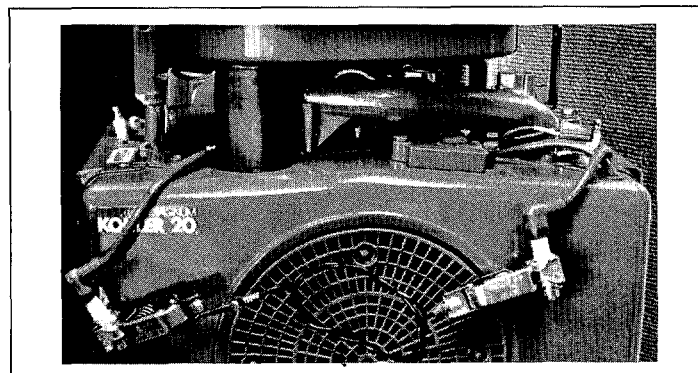


Figure 23. Ignition System Tester

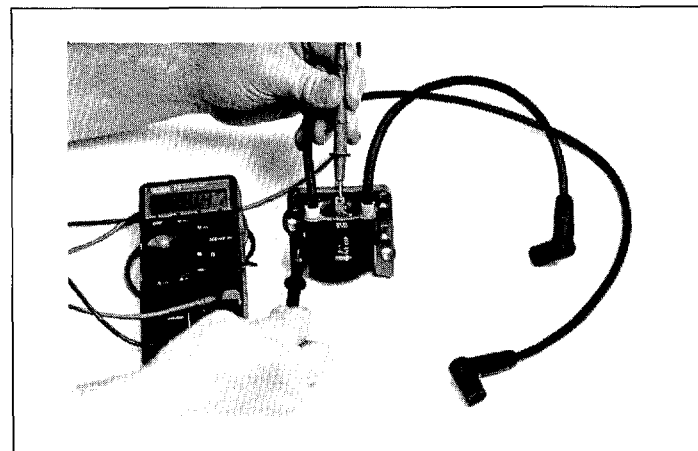


Figure 24. Testing Module Primary

volts to the ignition module can cause the module to burn out. This type of damage is not covered by the engine warranty.

A break-before-make type keyswitch is required to prevent damage to the ignition module.

Ignition Module REMOVAL

1. Remove the blower housing.
2. Remove the kill lead from kill terminal of module. Refer to Figure 26.
3. Remove the hex flange screws and module from bracket on #1 cylinder barrel.

INSTALLATION

1. Install the module and hex flange screws to bracket. Move the module as far from flywheel/magnet as possible—tighten the hex flange screws slightly.
2. Insert a .014" flat feeler gauge (or shim stock) between the magnet and module. Refer to Figure 27.

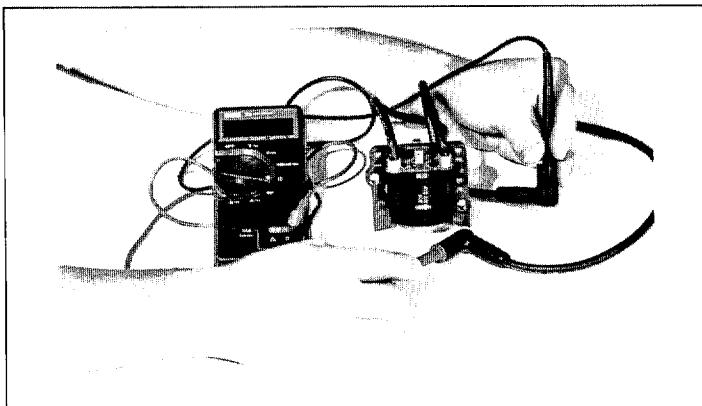


Figure 25. Testing Module Secondary

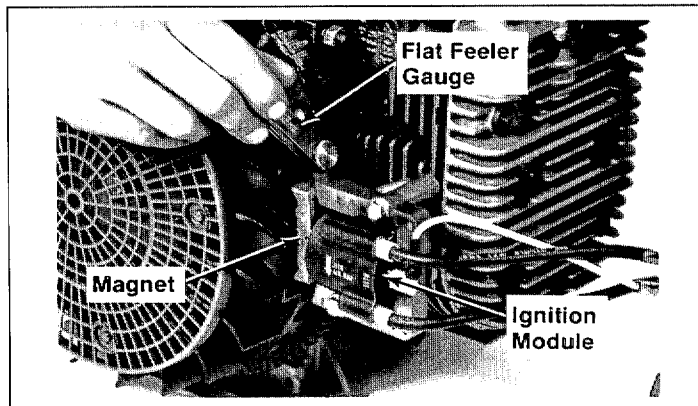


Figure 27. Setting Magnet-To-Module Air Gap

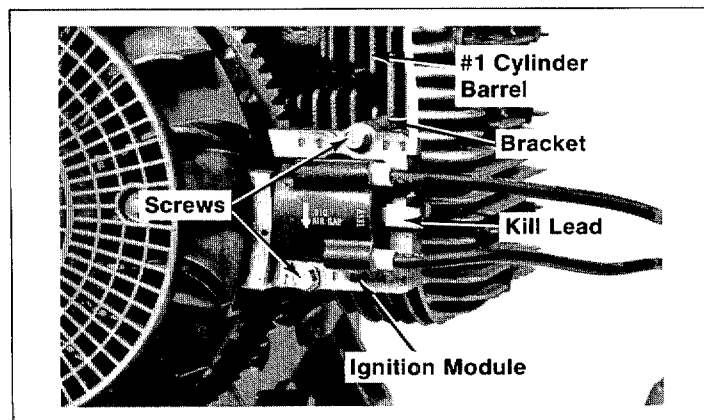


Figure 26. Removing Ignition Module

- Loosen the hex flange screw so the magnet pulls module against feeler gauge. Tighten the hex flange screw securely.
- Remove the feeler gauge or shim stock. Due to the pull of the magnet, the bracket and hardware will flex slightly. The magnet-to-module air gap should be within the range of .008/.012".
- Rotate the flywheel back and forth; check to make sure the magnet does not strike the module. Check gap with feeler gauge and readjust if necessary.
- Install the kill lead to kill terminal of module. Reinstall the blower housing.

Kill Lead With Optional Diode

An optional in-line diode is installed in the kill lead of some Magnum engines. This diode protects the module from burning out, in the event voltage is applied to the kill lead. Refer to Figure 28.

The diode is rated such that diode failure (and subsequent module burn out) is highly unlikely. In the event a module with a diode protected kill lead does burn out, the diode should be tested.

DIODE TEST

Use an ohmmeter (or continuity tester) to test the diode.

- Disconnect the kill lead terminals from the kill switch and ignition module.

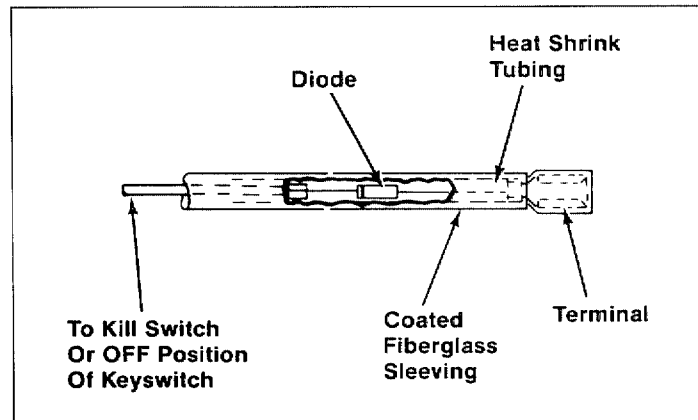


Figure 28. Kill Lead With In-Line Diode

- Place the meter leads (or tester leads) across the kill lead.

In one direction, the resistance should be infinity ohms (open circuit - no continuity). Reverse the test leads; some resistance should be measured (closed circuit - continuity).

- If the resistance is infinity ohms in both directions (no continuity), the kill lead or diode is open.
Cut the protective tubing to expose the leads of diode. Perform the resistance (or continuity) test in step 2 to the diode leads. This will confirm if the lead or the diode is at fault.
- If the resistance is 0 ohms in both directions (continuity), the diode is shorted.

KILL LEAD/DIODE REPLACEMENT

When servicing the kill lead, the entire lead can be replaced or, just the portion containing the diode. Refer to the appropriate Parts Manual for lead part numbers.

To replace the lead, the blower housing must be removed. Use the following procedure to replace just the portion of lead with diode.

- Cut off the diode portion of kill lead approximately 4 3/4" from terminal.
- Strip 1/4" of insulation from kill lead.
- Crimp the "insulink" connector of replacement diode/lead assembly to kill lead.

IGNITION SYSTEM TROUBLE SHOOTING GUIDE

The following guide will help locate and correct ignition system-related starting problems. This procedure uses a simple tester which can be easily made by the serviceman. Refer to the "Special Tools" section for ignition system tester construction details.

NOTE: Use a low voltage ohmmeter when ohmmeter is required. Always zero ohmmeter on each scale before testing to ensure accurate readings.

PROBLEM: Engine Will Not Start

Test	Conclusion
Make sure spark plug leads are connected to spark plugs.	
Check condition of spark plugs. Make sure gaps are set to .025".	If plugs are in good condition, check/adjust gaps and reinstall.
Check ignition module using test plugs (refer to Figure 23).	If visible and audible sparks ARE produced, the ignition module is OK.
Remove the high-tension leads from the engine spark plugs, and connect them to the test plugs.	If visible and audible sparks ARE NOT produced:
NOTE: To maintain engine speeds normally obtained during cranking, do not remove the engine spark plugs.	Make sure engine ignition switch and/or keyswitch are in the "run" position.
Make sure the engine ignition switch (kill switch) and/or keyswitch are in the "run" position.	Check wires and terminals of ignition module and other components for accidental grounding and/or damaged insulation.
Crank the engine and observe the test plugs. Visible and audible sparks should be produced.	If wires and terminals are OK, the ignition module is probably faulty and should be replaced. Test module further using an ohmmeter (Test 4).
(4) Measure the primary resistance of module using an ohmmeter.	If resistance is low or 0 ohms, module primary is shorted. Replace module.
NOTE: Connect negative (-) lead of ohmmeter to kill terminal B. Refer to Figures 22 and 24.	If resistance is high or infinity ohms, module primary is open. Check keyswitch/wiring for shorts or connections which could apply 12V to kill terminal B. Correct those conditions, then replace module.
Primary Leads/Terminals - A - B	
Primary Resistance - 1.0/1.5 ohms	If resistance is within range, module primary is OK. Test secondary (Test 4b).
(4b) Measure the secondary resistance of module using an ohmmeter. Refer to Figures 22 and 25.	If resistance is within range, module secondary is OK.
Secondary Leads/Terminals - C - D	If resistance is low or 0 ohms, module secondary is shorted. Replace module.
Secondary Resistance - 22,000/42,000 ohms	If resistance is high or infinity ohms, module secondary is open. Replace module.

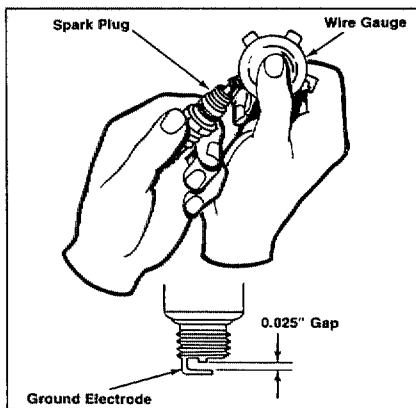
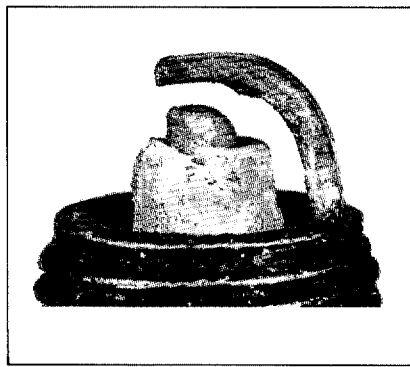
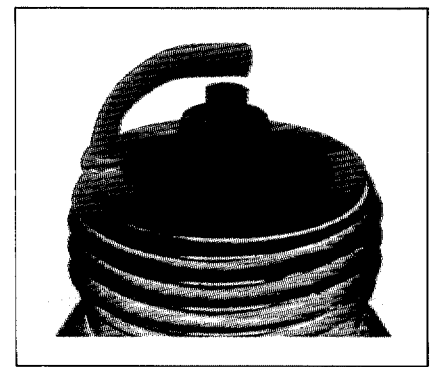


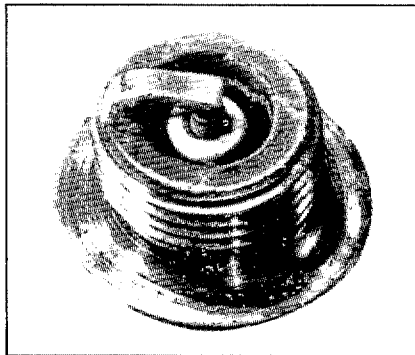
Figure 29. Servicing Spark Plug



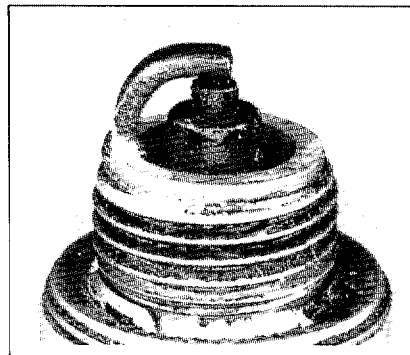
Worn: On a worn plug, the center electrode will be rounded and the gap will be eroded .010" or more than the correct gap. Replace a worn spark plug immediately.



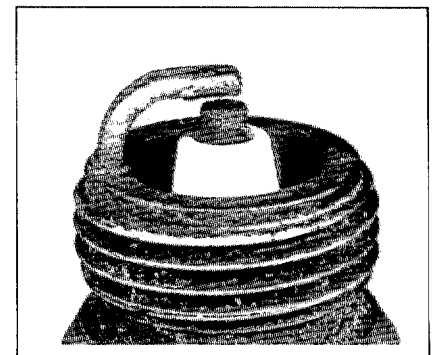
Carbon Fouled: Soft, sooty, black deposits indicate incomplete combustion. Incomplete combustion is usually caused by overrich carburetion, weak ignition, or poor compression.



Normal: A plug taken from an engine operating under normal conditions will have light tan or gray colored deposits. If the center electrode is not worn, a plug in this condition could be regapped and reused.



Wet Fouled: A wet plug is caused by excess fuel, or oil in the combustion chamber. Excess fuel could be caused by operating the engine with too much choke. Oil in the combustion chamber is usually caused by worn piston rings or valve guides.



Chalky White Deposits: Chalky white colored deposits indicate overheating. This condition is usually accompanied by excessive gap erosion. A clogged grass screen, clogged cooling fins, and lean carburetion are some causes of over-heating.

SPARK PLUGS CONDITION DIAGNOSIS

Engine misfire or starting problems are often caused by spark plugs in poor condition or with improper gap setting.

SERVICE

Every 100 operating hours remove the spark plugs, check condition, and reset gaps or replace with new plugs as necessary. Refer to Figure 29.

1. Before removing the spark plugs, clean the area around the base of plugs to keep dirt and debris out of the engine.
2. Remove the plugs and check condition. Replace the plugs if worn or if reuse is questionable.

CAUTION: Do not clean the spark plugs in a machine using abrasive grit. Some grit could remain in spark plugs and enter the engine causing extensive wear and damage.

3. Check the gaps using a wire feeler gauge. Adjust gaps to 0.025" by carefully bending the ground electrode.

4. Reinstall the spark plugs into cylinder heads. Torque plugs to 10/15 ft. lb.

INSPECTION

Inspect the spark plugs as soon as they are removed from the cylinder heads. The deposits on the tips are an indication of the general condition of piston rings, valves, and carburetor.

Normal and faulty spark plugs are shown in the following photos.

BATTERY CHARGING SYSTEM

ELECTRICAL SYSTEMS WIRING DIAGRAMS AND BATTERY CHARGING SYSTEMS

□ 15 Amp Regulated Battery Charging System

CAUTION: To prevent damage to the electrical system and components:

1. Make sure battery polarity is correct. A negative (-) ground system is used.
2. Disconnect the rectifier-regulator leads and/or wiring harness plug before electric welding is done on the equipment powered by the engine. Also disconnect other electrical accessories in common ground with the engine.
3. Prevent the stator (AC) leads from touching or shorting. This could permanently damage the stator.

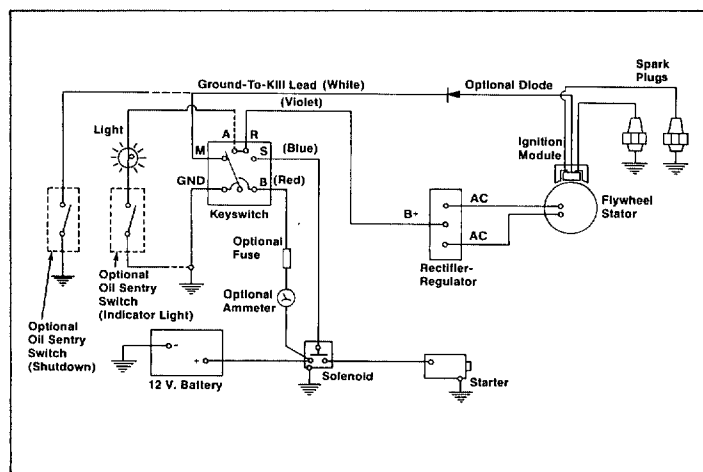


Figure 30. Wiring Diagram - Electric Start Engines/15 Amp Regulated Battery Charging System

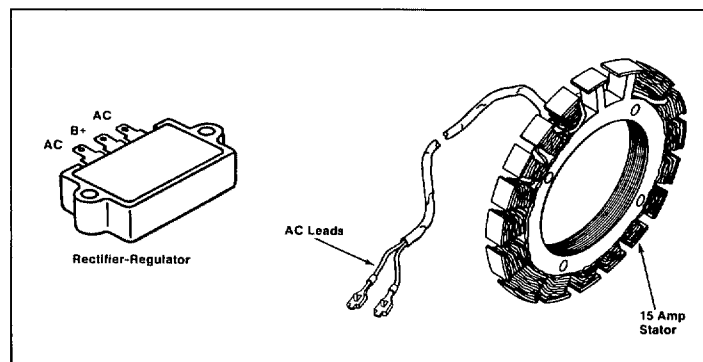


Figure 31. 15 Amp Stator And Rectifier-Regulator

Battery Charging

WARNING: Dangerous Acid, Explosive Gases! Batteries contain sulphuric acid. To prevent acid burns, avoid contact with skin, eyes, and clothing.

Battery Maintenance

Regular maintenance will ensure the battery will accept and hold a charge.

1. Regularly check the level of electrolyte. Add distilled water as necessary to maintain the recommended level.

CAUTION: Do not overfill the battery. Poor performance or early failure due to loss of electrolyte will result.

2. Keep the cables, terminals, and external surfaces of battery clean. A build-up of corrosive acid or grime on the external surfaces can self-discharge the battery. Self-discharging happens rapidly when moisture is present.

Wash the cables, terminals, and external surfaces with a baking soda and water solution. Rinse thoroughly with clear water.

CAUTION: Do not allow the baking soda solution to enter the cells as this will destroy the electrolyte.

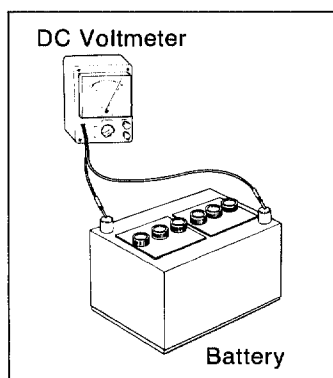


Figure 32. Checking Battery Voltage

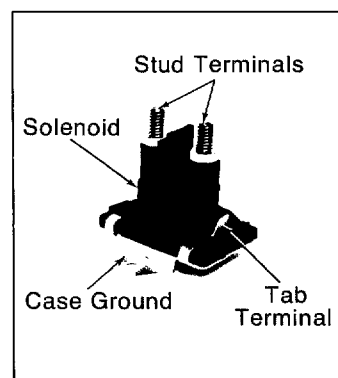


Figure 33. Starter Solenoid

SOLENOID

A solenoid is used on engines equipped with an instrument panel or keyswitch. The solenoid is an electrically-actuated normally open switch designed for heavy current loads. Refer to Figure 33.

The solenoid is used to switch the heavy current required by the starter using the keyswitch (designed for low current loads).

Testing

1. Connect an ohmmeter or continuity tester across the stud terminals of solenoid.
2. Apply 12 volts DC across the tab terminal and case ground of solenoid and observe ohmmeter or tester.

NOTE: Apply positive (+) of voltage supply to tab terminal; negative (-) to case ground.

3. The ohmmeter or tester should indicate continuity as long as voltage is applied. If there is no continuity, the solenoid is probably faulty and should be replaced.

Check the solenoid further using an ohmmeter (step 4).

4. Measure the resistance of the coil in the solenoid using an ohmmeter. Connect one meter lead to the case ground and one lead to the tab terminal.

If the resistance is 5.2/6.3 ohms, the coil is OK.

If the resistance is low or 0 ohms, the coil is shorted. Replace solenoid.

If the resistance is infinity ohms, the coil is open. Replace solenoid.

ELECTRIC STARTER

These engines use a permanent magnet, bendix-drive electric starter. Refer to Figure 34.

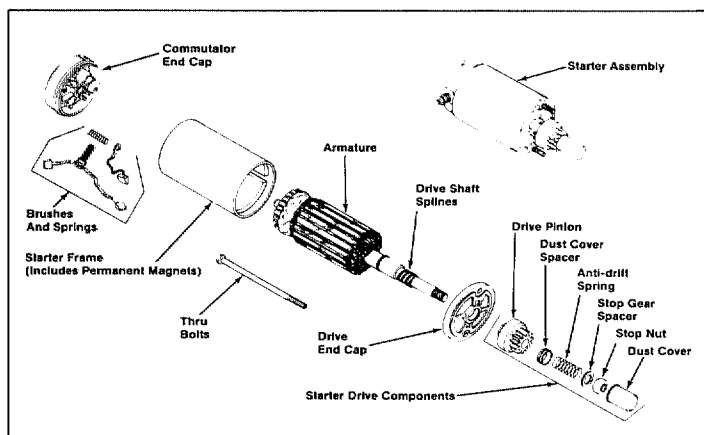


Figure 34. Bendix Drive Electric Starter

TROUBLE SHOOTING GUIDE 15 AMP BATTERY CHARGING SYSTEM

NOTE: Zero ohmmeters and voltmeters on each scale to ensure accurate readings. Voltage tests should be made with engine running at 3600 RPM - no load. Battery must be fully charged.

PROBLEM: No Charge To Battery

Test	Conclusion
Insert an ammeter in B+ lead from rectifier-regulator. With engine running at 3600 RPM and B+ lead connected, measure the voltage from B+ (at terminal on rectifier-regulator) to ground using a DC voltmeter.	If charge rate increases when load is applied, the charging system is OK and battery was fully charged.
If voltage is 13.8 volts or more, place a minimum load of 5 Amps* on battery to reduce voltage. Observe ammeter.	If charge rate does not increase when load is applied, test stator and rectifier-regulator (tests 2 and 3).
*NOTE: Turn on lights, if 60 watts or more. Or place a 2.5 ohm, 100 watt resistor across battery terminals.	
Remove connector from rectifier-regulator. With engine running at 3600 RPM, measure AC voltage across stator leads using an AC voltmeter.	If voltage is 28 volts or more, stator is OK. Rectifier-regulator is faulty. Replace the rectifier-regulator.
	If voltage is less than 28 volts, stator is probably faulty and should be replaced. Test stator further using an ohmmeter (test 3).
With engine stopped, measure the resistance across stator leads using an ohmmeter.	If resistance is 0.1/0.2 ohms, the stator is OK.
	If resistance is 0 ohms, the stator is shorted. Replace stator.
	If resistance is infinity ohms, stator is open. Replace stator.
With engine stopped, measure the resistance from each stator lead to ground using an ohmmeter.	If resistance is infinity ohms (no continuity), the stator is OK (not shorted to ground).
	If resistance (or continuity) is measured, the stator leads are shorted to ground. Replace stator.

PROBLEM: Battery Continuously Charges At High Rate

Test	Conclusion
With engine running at 3600 RPM, measure voltage from B+ lead to ground using a DC voltmeter.	If voltage is 14.7 volts or less the charging system is OK. The battery is unable to hold charge. Service battery or replace as necessary.
	If voltage is more than 14.7 volts, the rectifier-regulator is faulty. Replace rectifier-regulator.

MAINTENANCE PROCEDURES

To avoid costly repairs and down-time, it is imperative to develop and practice good maintenance procedures from the beginning. These procedures fall into daily, weekly, monthly and quarterly increments, and are outlined below. We have provided a maintenance log for your convenience on next page; it is recommended that you affix a copy of the log on the vehicle door near your unit for convenience and to serve as a maintenance reminder.

Daily

- Check engine oil level.
- Inspect garden hose screen - clean as needed.
- Visually inspect machine for loose wires, oil leaks, water leaks, etc.
- Inspect recovery tank s/s filter and filter bag for tears, holes, etc. - clean, repair or replace as needed.
- Lubricate blower with LPS-1 or WD-40 through blower inlet.

Weekly

- Change engine oil. (25-30 hours of operation.)
- Check engine air cleaner filter - clean as necessary.
- Check high pressure pump oil - add as necessary.
- Check drive coupler set screws - tighten as needed.
- Check pump drive belt for wear - tighten as needed.
- Check pump pulleys - tighten as needed.
- Check fuel lines for wear/chafing.
- Check all nuts and bolts - tighten as needed.
- Check heater burner assy. union for tightness/leaks.
- Clean vacuum tank thoroughly with high pressure washer.
- Flush water and chemical system with 50/50 white vinegar solution.
- Check engine RPM's - adjust to 2600 RPM's at the pump.

Monthly

- Grease blower bearing fittings.
- Remove pressure bypass valve stem, grease cup and stem, reinstall.
- Check water level in battery. Clean connections as needed.

Quarterly

- Change oil in blower.
- Check engine compression.
- Check for combustion chamber carbon deposit.
- Change spark plugs.

IMPORTANT: Record date and machine hours on maintenance chart.

OVERALL CARE OF UNIT

MAINTAINING THE ORIGINAL APPEARANCE OF YOUR UNIT IS IMPORTANT FOR TWO REASONS:

1. It represents a big dollar investment for your cleaning business and its appearance should reflect that fact. A dirty machine is not professional!
2. Maintenance, troubleshooting, and repair is much easier to accomplish on a clean well maintained unit. Regular cleaning of the machine offers you an opportunity to visually inspect all facets of the machine and spot potential problems before they occur.

FOLLOWING MAINTENANCE IS RECOMMENDED BY THE MANUFACTURER AT THE FREQUENCY INDICATED.

After each job: Check recovery tank, s/s filter and filter bag as required.

Daily: Wipe machine down thoroughly with a damp cloth; flush recovery tank out thoroughly. Empty filter bag and inspect for rips, tears, etc. - replace as needed; remove, thoroughly clean and reinstall stainless steel filter screen in recovery tank; inspect and clean vacuum slot on cleaning wand; check wand head for sharp edges that could tear carpet - file down as needed; clean wand to maintain original appearance; wipe down vacuum and high pressure hoses as needed - visually inspect for cuts, etc.

Weekly: Wipe down entire unit as needed - apply good coat of auto wax to all painted surfaces inside and out, and to control panel; thoroughly clean recovery tank using high pressure hot water (unit with optional high pressure cleaning gun may be used for this); remove stainless steel filter in recovery tank, thoroughly clean removing all lint build-up, inspect for damage and reinstall. Remove filter bag, thoroughly clean and reinstall - if torn, replace; empty chemical from chemical container, wash out thoroughly to remove any chemical build-up; inspect chemical feed line strainer and use 50% white vinegar/water solution to remove any chemical build-up; thoroughly clean wand and inspect for clogged jet, debris in vacuum slot and leaking fittings at valve. Apply light coat of auto wax to wand thoroughly clean vacuum and high pressure hoses including hose cuffs - inspect for wear or damage to hoses and quick connect fittings. Inspect garden hose connect/adaptor screen for debris, remove and clean thoroughly. Inspect all lines for wear or abrasions that may cause possible leaks.

MAINTENANCE LOG

DAILY CLEANING & INSPECTION

Engine oil - check Clean vac tank filter bag after every job
 Garden hose screen - clean Blower inlet - spray with LPS 1 after last job
 Machine - general inspection

WEEKLY SERVICE

MAX HRS	SERVICE	DATE/HRS	DATE/HRS	DATE/HRS	DATE/HRS	DATE/HRS	DATE/HRS	DATE/HRS
25	BLOWER check oil level							
25	PUMP OIL check (top of sight gauge)							
25	DRIVE SHAFT SYSTEM tighten set screws							
25	BELTS & PULLEYS check tightness							
25	HIGH PRESSURE LINES check for chafing							
25	NUTS & BOLTS check tightness							
25	BATTERY LEVELS check							
25	VACUUM TANK clean							
25	WIRING check for chafing							
25	CHEMICAL SYSTEM flush w/vinegar							

MONTHLY SERVICE

100	ENGINE OIL change							
100	BLOWER grease bearing							
100	ENGINE AIR CLEANER clean							
100	BY PASS VALVE grease cup & stem							

QUARTERLY SERVICE (3 MONTHS)

300	BLOWER OIL change							
300	ENGINE compression							
300	SPARK PLUGS change							

MAINTENANCE LOG

DAILY CLEANING & INSPECTION

Engine oil - check Clean vac tank filter bag after every job
 Garden hose screen - clean Blower inlet - spray with LPS 1 after last job
 Machine - general inspection

WEEKLY SERVICE

MAX HRS	SERVICE	DATE/HRS	DATE/HRS	DATE/HRS	DATE/HRS	DATE/HRS	DATE/HRS	DATE/HRS
25	BLOWER check oil level							
25	PUMP OIL check (top of sight gauge)							
25	DRIVE SHAFT SYSTEM tighten set screws							
25	BELTS & PULLEYS check tightness							
25	HIGH PRESSURE LINES check for chafing							
25	NUTS & BOLTS check tightness							
25	BATTERY LEVELS check							
25	VACUUM TANK clean							
25	WIRING check for chafing							
25	CHEMICAL SYSTEM flush w/vinegar							

MONTHLY SERVICE

100	ENGINE OIL change							
100	BLOWER grease bearing							
100	ENGINE AIR CLEANER clean							
100	BY PASS VALVE grease cup & stem							

QUARTERLY SERVICE (3 MONTHS)

300	BLOWER OIL change							
300	ENGINE compression							
300	SPARK PLUGS change							

WARRANTY INFORMATION

To avoid misunderstandings which might occur between machine owners and manufacturer, we are listing causes of component failure that specifically voids warranty coverage. Such causes as listed below shall constitute **abuse or neglect**.

BLOWER: Failure to lubricate impellers daily with LPS-1 or WD-40 lubricant. Failure to lubricate bearings as recommended in blower manual. Failure to maintain proper oil levels in the blower. Failure to use the correct oil grade and viscosity as recommended in blower manual. Failure to properly maintain blower safeguard systems such as waste tank filter screen, vacuum safety relief valve in vacuum tank lid and waste tank automatic shut-off system. Allowing foam to pass through blower.

HIGH PRESSURE WATER PUMP: Operation of pump at pressures over 1200 PSI. Failure to maintain proper oil level as recommended in pump manual. Failure to change oil in pump at recommended intervals. Failure to protect pump against freezing. Failure to maintain pump protection shut-off system. Failure to use water softener in hard water areas. Use of improper chemicals.

VAC TANK: Failure to properly maintain filtering devices in tank. Failure to clean tank as recommended by manufacturer. Failure to maintain vacuum safety release in tank lid. Use of improper chemicals.

CHEMICAL PROPORTIONER: Use of improper chemical. Failure to use water softener in hard water area. Operating machine without proper chemical filter screen. Failure to protect against freezing.

CONTROL PANEL: Failure to protect flow meter and water pressure gauge against freezing.

VACUUM AND SOLUTION HOSES: Failure to protect hoses against freezing. Failure to protect hoses against burns from engine/blower exhaust. Damage to hoses from being run over by vehicles. Kinking or cracking from failure to store or unroll hoses correctly. Normal wear and tear from everyday use.

CLEANING WAND: Failure to protect against freezing. Obvious physical abuse of wand.

WARRANTY PROCEDURE

Warranty coverage is available to you **ONLY** through HydraMaster Corporation, 20309 64th Ave. West, Lynnwood, Washington 98036. When warranty parts are needed, write **HydraMaster Warranty Dept.** at the above address, or call the Warranty/Service Dept. at (206) 775-7275. **No collect calls will be accepted. Hours of Warranty/Service Dept. are 8:00 am to 6:00 pm Pacific Time.**

IMPORTANT

HydraMaster's warranty policy provides replacement parts without charge for thirty (30) days to customers maintaining current account status. An invoice dated thirty (30) days from date of replacement parts shipment will be sent to the customer for the amount of the parts sent. The customer's faulty parts **must be returned** for evaluation prior to the expiration of the thirty (30) day period. Upon warranty approval, a credit will be issued the customer for the replacement parts invoice. **Warranty disapproval or failure to return the faulty parts within the thirty (30) day period allowed will result in the customer being charged for the replacement parts sent.**

HydraMaster LIMITED WARRANTY

HydraMaster warrants products of its manufacture to be free from defects in material and workmanship if properly installed, maintained, and operated under normal conditions with competent supervision. No person, agent, representative or dealer is authorized to give any warranties on behalf of HydraMaster nor to assume for HydraMaster any other liability in connection with any of HydraMaster's products. This warranty shall extend for the periods listed by component below from date of installation. If repairs or replacements are made by the Purchaser without HydraMaster's written consent, HydraMaster's warranty shall cease to be in effect. No allowance will be granted for any repairs or alterations made by the Purchaser without HydraMaster's prior written consent.

Machinery, equipment and accessories furnished by HydraMaster, but manufactured by others, are warranted only to the extent of the original manufacturer's warranty to HydraMaster.

HydraMaster agrees at its option to repair at the point of shipment or to replace without charge f.o.b. point of shipment, any parts or parts of products of HydraMaster's manufacture, which within the specified warranty period shall be proved to HydraMaster's satisfaction to have been defective when shipped, provided the Purchaser promptly notifies HydraMaster, in writing, of such alleged defect.

HydraMaster's liability to Purchaser, whether in contract or in tort arising out of warranties, representation, instructions, or defects from any cause shall be limited to repairing or replacing of the defective part or parts as aforesaid, f.o.b. point of shipment.

No liability whatsoever shall attach to HydraMaster until said products have been paid for.

Except as stated in this section and in the preceding section titled "Warranty" and except as to title, there are no guarantees or warranties of merchantability, fitness, performance or otherwise, express, implied or statutory, and HydraMaster shall have no liability for consequential, incidental or other damages, howsoever caused.

ENGINE: (Thru original Manufacturer.)

VACUUM BLOWER: (Thru original Manufacturer.
See Cooper Industries warranty.) 2 years

VACUUM RECOVERY TANK/CHEMICAL MIX TANKS: 3 years

FRAME/COVER ASSEMBLIES: 3 years

HIGH PRESSURE PUMP: (Thru original Manufacturer.
See Cat Pump warranty.) 1 year

HIGH PRESSURE BY PASS VALVE: 90 days

CHEMICAL PROPORTIONING SYSTEM: 90 days

INTERNAL MACHINE HOSE: 1 year

**EXTERNAL VACUUM HOSE, SOLUTION HOSE,
QUICK CONNECTORS:** 30 days

CLEANING WAND: (Except valve & jet assembly) 1 year

BELTS, FITTINGS, O-RINGS, FILTER SCREENS: 30 days

FILTER BAGS: Not Covered by Warranty

Freezing of any one water or chemical related component will **VOID** all other implied warranty on all water or chemical related components, internal or external, of this equipment.

HYDRA—————